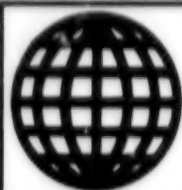


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20 JUNE 1989



**FOREIGN
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JPRS Report

Science & Technology

USSR: Materials Science

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JPRS-UMS-89-003

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Purposes of Open-Space Materials Studies and Assembly Operations

18420081d Tashkent PRAVDA VOSTOKA in Russian
10 Dec 88 p 3

[Article by A. Pokrovskiy]

[Excerpt] Aleksandr Volkov and Jean-Loup Chretien began carrying out experiments called "Obraztsy" (specimens) and "Era" on the outside of the "Mir" station, while Valdimir Titov, Musa Manarov, and Valeriy Polyakov followed their actions from inside the station. Sergey Krikalev was on duty at a control desk.

On the screen of a television set at the Flight Control Center, Chretien could be seen moving slowly along the surface of the station, carrying a panel with specimens of materials which a special commission had selected in the course of a broad scientific competition. For about half a year, these specimens will feel the effects of factors of open space. Soviet cosmonauts must then remove them, during the next egress, and deliver them to Earth for further study of their physical and chemical characteristics, so that they can be used in space and on Earth.

The next experiment, "Era," is also a step toward industrialization of space. From a bundle of tubes made of a carbon-filled plastic, Aleksandr Volkov and Jean-Loup Chretien assembled a structure which can serve in the future as a platform for various antennas or a large unit. From his control desk, Sergey Krikalev issued commands for opening up this structure.

UDC 621.039.532.21

Change in Elastic Characteristics of Structural Carbon Materials Upon Neutron Bombardment

18420088 Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov-Dec 88
(manuscript received 13 Feb 88) pp 14-19

[Article by Yu. S. Virgilev, L. L. Lyshov, V. N. Baranov, and A. I. Plavskiy, Moscow]

[Abstract] A study is made of the relationship between dynamic and static elasticity moduli, and the Poisson ratio is determined for a number of carbon materials bombarded under various conditions of temperature and neutron flux. The moduli determined by the dynamic method based on transmission of ultrasound and computed from the crack resistance of the material coincide within the limits of accuracy of the determination. The static elasticity modulus coincides or is 10-30 percent lower. The Poisson ratio changes by 20-25 percent upon bombardment of reactor graphite and similar carbon materials. References 4: 3 Russian, 1 Western (in Russian translation).

State Prize Winner for Research of Solid-Surface Processes Interviewed

18420081c Tashkent PRAVDA VOSTOKA in Russian
27 Nov 88 p 2

[Article by S. Fioletov, correspondent]

[Abstract] The article is an interview with Utkur Khasanovich Rasulev, corresponding member of the Uzbek Academy of Sciences and director of the academy's Institute of Electronics, regarding a work-cycle entitled "Surface-Ionization and Thermal-Desorption Studies of Electronic, Atomic and Molecular Processes on the Surface of Solids, and Applications of this Research." Rasulev is a member of a group which was awarded the 1988 USSR State Prize for this work. Among the other participants in this project, which lasted 20 years, were leading specialists of Physical-Technical Institute imeni Ioffe, the USSR Academy of Sciences' Institute of Atomic Energy imeni Kurchatov and the Ukrainian Academy of Sciences' Institute of Physics. Results of the group's research are summarized in a book by Rasulev which Pergamon Press published recently in the United States.

Academician K. I. Zamarayev, academician N. D. Devyatkov, chairman of the USSR Academy of Sciences' scientific council on the problem "Physical Electronics", and M. L. Aleksandrov, corresponding member of the USSR Academy of Sciences and general director of the academy's Scientific-Technical Association, are quoted in regard to achievements of Rasulev and his colleagues. They are credited in particular with original research of surfaces at high temperatures, establishing the main regularities involved in thermal ionization, and demonstrating that a number of classes or organic compounds possess surface-ionization capabilities, which has substantially expanded the applicability of surface ionization. Aleksandrov mentions that the group's work has provided a basis for broad introduction of mass spectrometry into scientific experimentation, and for development of serially-produced mass spectrometers and electronic spectrometers for diagnosing surfaces.

Rasulev relates that he and his colleagues have proposed more than 25 original methods for diagnosing different surfaces, and they have solved problems of combating corrosion of metal surfaces, among other things. One of their findings is that amines and their derivatives ionize with an effectiveness close to unity. On the basis of regularities which have been discovered in ionization of organic compounds, Rasulev's institute is building detectors which are tens of thousands of times as sensitive as foreign counterparts. A single molecule of an amine or amine derivative in 1 quadrillion molecules of air can be detected by the surface-ionization method, it is claimed. Rasulev suggested that methods which the scientists have developed for identifying different types of molecules might be used in investigatory work. Individuals might be identified on the basis of amines which their organisms exude, for example.

A photograph of U. Kh. Rasulev is given.

UDC 539.37:669.018.2

Reversible Shape Memory Effect Resulting From Thermal Cycle Training Under Load

18420046c Kiev *PROBLEMY PROCHNOSTI* in Russian No 7, Jul 88 (manuscript received 8 Jul 86) pp 50-54

[Article by S. P. Belyayev, S. L. Kuzmin, and V. A. Likhachev, Leningrad University imeni A. A. Zhdanov]

[Abstract] The training effect in martensite motors may be so great that useful work per cycle is maximized by completely releasing the load during cooling. More complete and expedient utilization of reversible shape memory in repeatedly used power devices requires a systematic study of the influence of thermal cycling under load on reversible shape memory, the subject of the present article. Studies were performed on $\text{Ti}_{50}\text{Ni}_{47.5}\text{Cu}_{2.5}$ alloy,

cylindrical specimens of which 4 mm in diameter and 35 mm in length were annealed at 770 K for 3 hours. Specimens were loaded by a constant torque and thermally cycled. Plasticity occurred during cooling, shape memory upon heating. The shape memory effect generated by thermal cycling under load was not proportional to the residual deformation, as is the case for isothermal loading. The amount of shape memory depends essentially on the number of preliminary heating and cooling cycles under load, the effect being greater after greater numbers of thermal cycles. This influence of repeated martensite-austenite transitions is explained by the peculiarities of the processes of heredity of crystalline lattice defects. Thermal cycling of titanium nickelide under external loading can result in two shape memory effects with opposite signs. After thermal cycling training under considerable stress, the spontaneous shape change of the material may be complex, accompanied by a change in the direction of deformation with a monotonic increase or decrease of temperature. References 16: 13 Russian, 3 Western (1 in Russian translation).

UDC 620.198

Electrochemical Continuity Control of Brass Coating on Steel. Adhesion of Coated Steel to Rubber

18420130d Moscow ZASHCHITA METALLOV in Russian Vol 25 No 1, Jan-Feb 89 (manuscript received 23 Jun 87) pp 160-163

[Article by D. de Filippo and A. Rossi, Institute of General Inorganic and Analytical Chemistry, Cagliari University (Italy)]

[Abstract] Electrochemical monitoring of continuity for quality control of brass coating on steel is proposed in preference to immersion in HNO_3 with subsequent iron determination and to examination under a scanning electron microscope with an image analyzer or in a scanning Auger-spectrometer with chemical surface charting. The corrosion rate of the steel underneath the coating is determined from the Tafel slope of potentiodynamic polarization curves, the current density being measured at various potentials about the corrosion potential. The apparent density of the corrosion current averaged over the entire surface is an empirical parameter sufficiently sensitive to decrease of surface coverage. The method was tested on 70-30 brass coating inside a cell at a constant 18°C temperature with not more than 0.2°C deviation, this cell containing two auxiliary electrodes in addition to a reference electrode, a bubble counter, and a porous glass diaphragm for admission of nitrogen. Potentiodynamic polarization curves were plotted with an EGIG model 350 potentiostat including a computer and automatic compensation of the ohmic voltage drop, the sweep rate being 1 mV/s. The method is accurate, fast, and simple, requiring neither special skill nor expensive equipment, and the reproducibility of results is excellent. Its extensive use will facilitate statistical classification of materials and will confirm that at low apparent corrosion-current density adhesion of brass-coated steel to rubber does not depend on the degree of coverage but depends on the surface constitution of the steel. References 5: all Western.

UDC 621.744.37

Coatings With Complex Properties for Raw Iron-Coating Molds

18420126 Moscow LITEYNOYE PROIZVODSTVO in Russian No 1, Jan 89 pp 25-26

[Article by V. I. Zhmorschchuk, engineer, K. I. Vishnyakov, candidate of technical sciences, M. L. Motyl, engineer, A. A. Limonova, engineer, and S. A. Kaminskaya, engineer]

[Abstract] An experimental study of carbonaceous coatings for raw iron-casting molds was made, with coatings designed to harden the mold surface and to thus prevent entry of sand dust into the casting as well as into the

surrounding atmosphere. Bituminous varnish, petroleum asphalt, and bitumen diluted in kerosene were tested under factory conditions on AFL molds built at the Scientific Research Institute of the Technology of Tractor and Agricultural Machine Building and installed at the Pavlodar Tractor Plant. Excessive dilution with kerosene was found to soften the mold surface, but a preheated coating was found to minimize its crumbling. Replacement of a carbonaceous binder with an inorganic one such as liquid glass would require a denser coating. A technology of mold coating has been developed which will minimize entry of carbonaceous additive into the casting, thus drastically improving the economy of coating material, and will eliminate crumbling of the mold by stabilizing its surface after 60 min. The coating can be deposited nonuniformly, to match different requirements within the mold, and the process can be automated. The coating must be deposited air-free, however, the equipment for which with wide regulation of the feed rate is still being developed. Such a coating process is more hygienic.

UDC 621.891

Wear Resistance of Detonation Coatings Containing MoS_2

18420120a Kiev POROSHKOVAYA METALLURGIYA in Russian No 1, Jan 88 (manuscript received 12 Feb 87) pp 25-28

[Article by V. Kh. Kadyrov, L. A. Kotlyarenko, V. V. Shchepetov, and V. A. Voytov, Institute of Materials Science Problems]

[Abstract] An experimental study of detonation antifric-tion coatings produced from a composite material with MoS_2 on a nichrome base alloyed with B and Al was made for a determination of their wear characteristics. Tests performed under a load of 1 MPa, after thorough desiccation at a temperature of 140-160°C, have revealed that the wear rate is minimum when the coating contains 6 wt.pct MoS_2 and increases rapidly as the MoS_2 is either decreased or increased. The wear rate of this optimum coating, just as the friction coefficient, was found to first decrease sharply as the rubbing velocity was increased from 0.05 to 0.1 m/s and then, after some further decrease, to level off as the rubbing velocity was increased beyond 0.4 m/s, while the coating temperature rose from 60 to 190°C. This coating was tested for compatibility on friction pairs made of the same material or of different materials: hardened CrWMn and 30CrMnSiN₂ alloy steels, 45 carbon steel, 6-6-3 Sn-Zn-Pb bronze. The load dependence of the wear rate was measured at a constant rubbing velocity of 0.2 m/s. The friction coefficient did not exceed 0.06-0.15 in any pair under all test conditions. The wear rate was lowest on alloy steels and on bronze. References 6: 5 Russian, 1 Western (in Russian translation).

UDC 620.193.41

**Corrosion Properties of Vacuum-Plasma
Nitride-Titanium VT-8 Alloy-Based Coatings**
18420087c Moscow ZASHCHITA METALLOV in
Russian Vol 24 No 6, Nov-Dec 88 (manuscript received
14 Apr 87; after revision 14 Sep 87) pp 996-998

[Article by L. I. Pyatykhin, V. G. Padalka, V. V. Kunchenko, Ye. P. Gurin, Ye. Ye. Kudryavtseva, T. T. Kravchenko, and L. I. Soprykin, Kharkov Higher Military Aviation Engineering School]

[Abstract] A study is made of the corrosion resistance of nitride coatings as a function of the nitrogen pressure used in the formation of the coatings. Specimens of VT-8 alloy containing Al 6.5, Mo 3.0 and Si 0.36 percent were

used, with the coatings applied to the end of cylindrical specimens in a vacuum chamber at a nitrogen pressure of 0.01-9.3 Pa. Corrosion resistance was evaluated in 3 percent NaCl by a potentiostatic method using a silver chloride comparison electrode. Materials with most nearly perfect structure also had greatest corrosion resistance. Decreasing the relative content of droplets in the coating from 20 to 5 percent caused a tendency to increased corrosion resistance, although crystalline structure distortions veiled the effect. It is clearly seen only for droplet-free monophasic coatings, which have a significantly lower corrosion rate than the uncoated specimens. Condensation conditions favoring homogeneous single-phase coatings without titanium droplets, with maximum density and minimum lattice distortion, are therefore best from the standpoint of corrosion resistance. References 9: all Russian.

UDC 621.791.44.002:[669.295+669.715]

**Welding of VT1-0 Titanium With KAS-1A
Composite Materials**

18420096C Kiev AVTOMATICHESKAYA SVARKA in
Russian No 9 Sep 88 (manuscript received 4 Jan 87)
pp 37-41

[Article by V. N. Zamkov, V. R. Ryabov, doctor of technical sciences, V. K. Sabokar, candidate of technical sciences, A. N. Muraveynik, I. S. Dykhno, engineers, and I. Ya. Dzykovich, candidate of technical sciences, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences]

[Abstract] The weldability of KAS-1A composite material with VT1-0 technical titanium was studied and a plan for pressure welding of these materials was developed. KAS-1A is a composite of AV aluminum alloy with VNO-9 steel wire 0.15 mm in diameter, manufactured in the form of sheets containing 15, 25 or 40 percent reinforcing fiber. Each sheet has four rows of reinforcing fibers in its cross section. It was found that the temperature and pressure used in welding significantly influenced the strength of the KAS-1A layer in the composite. Optimal conditions are 480-520°C, 100-150 MPa. The use of soft intermediate layers of AD1 technical aluminum is not desirable, since the KAS-1A material is damaged due to the great plastic deformation of the matrix. Figures 6, references 13: Russian.

**Anodic Dissolution of Aluminum-Boron and
Aluminum-Carbon Fiber Composite Materials**

18420101b Kishinev ELEKTRONNAYA OBRABOTKA
MATERIALOV in Russian No 5, Sep-Oct 88
(manuscript received 4 Jun 86) pp 82-84

[Article by A. D. Davydov, A. N. Malofeyeva, N. M. Pashkova, and Ye. N. Kiriya, Moscow]

[Abstract] A study is made of the anodic behavior of two fiber composites: 0.14 mm diameter boron fiber in a matrix of AD1 aluminum alloy with 30 percent boron; and 6.7 μ m diameter carbon fiber in a matrix of Al2 aluminum alloy. Anodic potentiostatic and galvanostatic polarization curves were produced on nonmoving electrodes and anodic potentiodynamic curves were produced on rotating disk electrodes. The potentials for intensive dissolution of the Al-B composite material components differ greatly. Where the fraction of boron fibers is sufficient, the small quantity of aluminum in the surface layer of the electrode is dissolved quite quickly, the electrode potential increases, and the composite may be dissolved at high anode potentials corresponding to the potentials of the intensive dissolution of the boron. Uniform dissolution of the boron and carbon-based composites cannot be achieved under conditions of electrochemical machining. Carbon is not subject to electrical dissolution, the anodic current being expended in the decomposition of water with liberation of oxygen or discharging of the anions of the electrolyte, liberating chlorine upon electrolysis of NaCl solutions. Better results might be obtained by abrasive-electrochemical grinding or electric discharge-electrochemical machining. References 7: 6 Russian, 1 Western.

UDC 620.193

Pitting Resistance of Low-Carbon High-Cr Steels and Ni-Cr Steels

18420130b Moscow ZASHCHITA METALLOV
in Russian Vol 25 No 1, Jan-Feb 89 (manuscript
received 20 Aug 87) pp 103-105

[Article by B. V. Lebedev and I. G. Volikova, All-Union Scientific Research and Design Institute of Chemical Machine Building]

[Abstract] Two low-carbon high-Cr "superferrite" steels 01Cr18Mo2Ti and 01Cr25Mo2Ti along with, for comparison, two Ni-Cr steels 10Cr17Ni13Mo2Ti and 08Cr21Ni6Mo2Ti were tested for pitting in aqueous neutral NaCl solutions (pH 6.5-7.0), weakly acidic NaCl plus HCl solutions (pH 3) and strongly acidic NaCl plus HCl solutions (pH 1). The corrosion potential and the lowest galvanostatic pitting potential were measured in solutions containing 0.1-5 mol./l Cl-ions at temperatures of 20-95°C. A pitting potential at least 0.05 V higher than the corrosion potential served as the measure of pitting resistance. Galvanodynamic polarization curves were plotted, with the sweep varied over the 0.002-0.020 mA/s range, for selection of the galvanostatic polarization current in neutral NaCl solution. The lowest pitting temperature was determined only under conditions corresponding to a stable passive state. The results indicate that the pitting resistance of both "superferrite" steels is higher in neutral and weakly acidic media but lower in strongly acidic media than the pitting resistance of Ni-Cr steels with the same Mo content. The 01Cr25Mo2Ti steel was found to have the widest temperature range of pitting resistance, the 01Cr18Mo2Ti steel having the narrowest one with the lowest threshold temperature and Cl-ion concentration. References 8: 4 Russian, 4 Western (1 in Russian translation).

UDC 669.15'24'25'28'295-194:621.785.784

Dependence of Aging of High-Strength Steels on Structure of Initial Austenite and Martensite

18420121a Moscow IZVESTIYA AKADEMII NAUK
SSSR: METALLY in Russian No 1, Jan-Feb 89
(manuscript received 5 Oct 87) pp 68-75

[Article by I. P. Arsenyev, A. B. Dolgin, A. F. Yednral, L. M. Kaputkina, V. I. Kiriyeenko and V. G. Prokoshkina, Moscow]

[Abstract] An experimental study of two high-strength steels 01Ni17Co15Mo6Ti (17.3 pct Ni, 15.6 pct Co., 6.3 pct Mo, 0.80 pct Ti, 0.01 pct C, 0.0034 pct P, 0.0025 pct S, 0.019 pct O, 0.0051 pct N) and 01Ni10Co15Mo10 (10.1 pct Ni, 15.2 pct Co, 9.8 pct Mo, 0.28 pct Ti, 0.011 pct C, 0.0065 pct S, 0.016 pct O, 0.011 pct N) was made concerning the dependence of their aging process on the structure of initial austenite and martensite. Both steels were produced by vacuum-induction smelting. Phase

analysis was performed in a DRON-2.0 x-ray diffractometer with a FeK_{alpha}-radiation source. Structural changes were measured with a ULVACDL-1500 dilatometer under x12,500 magnifications. The fine structure was examined under Tesla BS-540 and JEM-100C electron microscopes as well as under an autoion microscope. Thermal effects were measured in a DSC HT-1500 calorimeter. Prior to aging, specimens were quenched (01Ni17Co15Mo6Ti steel from 900°C and from 1,000°C, 01Ni10Co15Mo10 steel from 1,050°C, after being held for 1 hour at the respective temperatures) and then subjected to high-temperature thermo-mechanical treatment (01Ni17Co15Mo6Ti steel at 950°C, 01Ni10Co15Mo10 steel at 1,050°C) resulting in either polygonization or recrystallization. This treatment was followed by cold deformation. Subsequent aging tests were performed at temperatures covering the 425-580°C range for up to 200 hours, maximum hardening being attained by aging at 500°C for 3 hours and not longer. Phase analysis under an electron microscope, x-ray diffractometry being inadequate because of the many phases possibly forming in the process, has identified round Fe₂Mo precipitates in both steels and also acicular Ni₃Ti precipitates in 01Ni17Co15Mo6Ti steel at 500°C even after 200 hours. References 7: all Russian.

UDC 669.14.018.41

Alloying and Heat Treatment of Cold-Resistant Dual-Phase Steels

18420121b Moscow IZVESTIYA AKADEMII NAUK
SSSR: METALLY in Russian No 1, Jan-Feb 89
(manuscript received 30 Oct 87) pp 98-104

[Article by A. M. Bernshteyn, Ye. M. Brun and L. S. Gorokhov, Moscow]

[Abstract] An experimental study of four cold-resistant steels was made concerning the dependence of their mechanical characteristics on the alloy content and on the heat treatment. They were produced either from primary iron by addition of alloying metals or from Armco iron by addition of ferroalloys, in a 100 kg capacity induction furnace with Ti or Al as deoxidizer. Those produced from primary iron were: 04Mn7Cr2VNb (0.046 pct C, 7.06 pct Mn, 2.04 pct Cr, 0.30 pct V, 0.44 pct Nb, 0.03 pct Mo), 10Mn5Ni2Cr2MoVNb (0.12 pct C, 5.06 pct Mn, 2.10 pct Cr, 2.13 pct Ni, 0.30 pct V, 0.18 pct Nb, 0.45 pct Mo), 10Mn5Ni2MoVNb (0.09 pct C, 5.09 pct Mn, 0.11 pct Cr, 2.11 pct Ni, 0.22 pct V, 0.16 pct Nb, 0.42 pct Mo). Those produced from Armco iron were: 10Mn7Cr2MoNb (0.104 pct C, 7.16 pct Mn, 1.86 pct Cr, 0.43 pct Mo, 0.48 pct Nb, 0.01 pct V), 10Mn5Ni2Cr2MoVNb (0.09 pct C, 5.03 pct Mn, 2.15 pct Cr, 2.10 pct Ni, 0.34 pct V, 0.17 pct Nb, 0.53 pct Mo), 10Mn5Ni2MoVNb (0.03 pct C, 5.13 pct Mn, 0.20 pct Cr, 2.09 pct Ni, 0.32 pct V, 0.16 pct Nb, 0.45 pct Mo). Ingots were forged at 1050-950°C, the forgings were hot-rolled at 980-900°C to 30 percent reduction, and the 12 mm thick strips were annealed at 1000°C for 1 hour.

Specimens cut from these strips were quenched from 850-900°C after being held for 0.5 hour at such a temperature, then tempered at temperatures within the 560-680°C range of the alpha-plus-gamma phase, and cooled in oil. They were subsequently tested for KCV impact value over the 20-(-196)°C temperature range with a type-11 pendulum and for tensile strength over the 20-(-100)°C range in an "Adamel Lomargie" machine at a strain rate of $6.67 \cdot 10^{-4} \text{ s}^{-1}$. The grain size was measured by the secants method in an "Epiquant" apparatus. Phase analysis was performed in a DRON-1.5 x-ray diffractometer with a FeK-radiation source and in a magnetometer by the Staebelin method. The critical temperatures were determined on the basis of measurements with an ULVAC dilatometer during heating at a rate of 5°/min and cooling at rates of 120-30°/min. Microimpurities were determined by the neutron-activation method. The results indicate that static and dynamic mechanical characteristics of alpha-plus-gamma steels depend largely on the ratio of the two phases in the microduplex structure and on the thermal stability as well as the regulated strain stability of second austenite at low temperatures, a determining factor also being the transformation of second austenite to martensite under stress at low temperatures. Replacement of up to 2 percent Mn with Ni was found to improve the stability of second austenite. References 8: 7 Russian, 1 Western.

UDC 669.14.018.54

Nonmagnetic High-Strength Steel for Heavily Loaded Parts of Transportation Equipment

18420121c Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 1, Jan-Feb 89 (manuscript received 13 Oct 87) pp 157-163

[Article by V. V. Glebov, N. M. Tyusina, Yu. N. Kalenikhin, I. L. Poymenov, V. V. Blinov, and V. Ye. Permitin, Moscow, Gorkiy]

[Abstract] An experimental study of nonmagnetic steels containing 19-25 pct Cr, 10.5-16.1 pct Mn, 4.8-8.3 pct Ni, 0.6-3.0 pct Mo, 0.07-1.34 pct V, 0.1-0.3 pct Si, and 0.37-0.76 pct N was made, the combined amount of Mo, V, and Si added for higher strength and corrosion not exceeding 2 pct. Nitrogen in the form of FeCrN-600 nitrous ferrochromium was added to the thoroughly deoxidized steel melt at a temperature not higher than 1550°C in an open induction furnace. Ingots were forged into rods 30 mm in diameter at various temperatures from 1200 to 1000°C and these were either quenched in water or cooled in air. The results of mechanical tests for strength characteristics, including the KCV impact value and plasticity characteristics together with microstructural examination and phase analysis for identification of nitrides and particularly Cr_2N , indicate that steel with a 0.65-0.75 pct N content attainable with 21-24 pct Cr and 12-15 pct Mn has a yield strength higher than 550 MPa and an impact value higher than 0.5 MJ/m^2 better mechanical characteristics and much higher corrosion

resistance than steels cooled in air after forging. Embrittlement-causing Cr_2N was found to precipitate fragmentarily at temperatures up to 110°C, with the fastest rate at 950°C. On this basis, 05Cr23Mn13Ni8MoN₂ steel containing 0.65-0.75 pct N can be recommended for non-weldable nonmagnetic heavily loaded parts of transportation equipment in preference to existing NN-3 nitrous steels. References 7: all Russian.

UDC 669.14.018.252.3:669.112

Effect of Modification on Structure and Properties of Cast Tungsten-Molybdenum High-Speed Tool Steels

18420131 Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 2, Feb 89 pp 27-32

[Article by A.S. Chaus and F.I. Rudnitskiy, Belorussian Polytechnical Institute]

[Abstract] The ameliorating effect of modifiers on the structure and properties of high-speed tool steels is evaluated on the basis of a comparative theoretical analysis and an experimental study. Modifiers of the first kind are elements with a melting point higher than that of iron and with a crystal lattice isomorphic or close to that of the high-temperature modification of the growing solid phase: Ta, Nb, B, Hf, Zr, Ti. Modifiers of the second kind, surface-active ones, are elements slightly soluble in both the growing solid phase and the liquid phase: Sr, Ca, Sb, Bi, Pb, Sn, Mg, Cd, Y, Ge. Characteristics which determine the effectiveness of a modifier are, in addition to crystal structure, melting point, and surface energy, also entropy in the standard state, heat of sublimation, statistical generalized moment, potential barrier to electrons and chemical affinity to oxygen and to hydrogen. Experiments were performed on R-6Mo5 and R-6Mo5Co5 steels. First 0.2 wt.pct of Zr, Ti, Hf, Nb, Ta, Co, B, Mn, Si, Ni, Cu, Al, Ca, Cd, Mg, Sr, Sn, Pb, Zn, Sb, Bi, rare-earth element, Y, Ge each was added one at a time to the steel melt in a resistance furnace, for an indication of the modifying effects on steel characteristics. In the case of a positive effect, the latter was then maximized by varying the amount of modifier. This procedure was followed by hardness and wear tests under a 200 N load on standard disk specimens in a Skoda-Savin machine before and after heat treatment, x-ray spectrum microanalysis in MS-46 and Camebax analyzers, metallographic structural and phase analysis, and, after impact tests, surface fractography under a UEMV-100K transmission electron microscope by the replicas method. The dendritic structure of the steel was found to be differently modified by each alloying element. Modifiers of the first kind were found to increase the heat resistance of steel. The surface-active ones were found to decrease it but to increase the wear resistance. For orientation, the effects of adding up to 0.6 pct Ti and up to 0.6 pct Bi are compared, these two elements being the most effective modifiers. They were also found to facilitate formation of nonmetallic inclusions and to til

cause "over-modification" when added in excessive amounts. References 23: 19 Russian, 1 Czechoslovak, 3 Western (2 in Russian translation).

UDC 669.14.018.252:621.785.92

Effect of Cryogenic Treatment on Structure of Quenched Steel

18420127a Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 1, Jan 89 (manuscript received 19 Jan 88) pp 113-117

[Article by A. I. Makhatilova, I. A. Tananko, and V. V. Belozarov, Kharkov Polytechnical Institute]

[Abstract] Cryogenic treatment by immersion in liquid nitrogen for 15-30 min was applied to nine quenched high-carbon steels for a determination of resulting structural changes and phase transformations. These steels included two with a martensitic structure after quenching (65Mn from 1000°C in oil, U7 straight-carbon tool steel from 1100°C in water), one with an austenitic structure after quenching (110Mn4 from 1000°C in oil), and six with an austenitic-martensitic structure after quenching (65Mn7 from 1000°C in oil, 72Mn2 from 1000°C in oil, 90Mn2 from 1000°C in oil, 80Ni10 from 1000°C in oil, CrWMn from 840°C in oil or from 1100°C in water, Cr15 ball-bearing steel from 840°C in oil or from 1100°C in water). Structural and phase analysis was performed in a DRON-3 x-ray diffractometer at room temperature before and after cryogenic treatment, the phase composition being determined on the basis of the gamma-phase (111) line to alpha-phase (110) line intensity ratio. A $\text{CoK}_{\beta\alpha}$ -radiation source was used for recording the (222) line as an indicator of the martensite structure. Cryogenic treatment was found not to produce structural changes in the martensitic steels and to produce homogeneous lamellar α_{M} -martensite in the austenitic steel. In the austenitic-martensitic steels it either changed the martensite structure without phase transformation (65Mn7) or also caused additional austenite-to-martensite transformation (72Mn2, 90Mn2, 80Ni10, CrWMn, Cr15). References 12: all Russian.

UDC 621.771.011

Dependence of Structure and Properties of Ball-Bearing Steel on Hot-Rolling Process Parameters

18420127b Moscow IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 1, Jan 89 (manuscript received 24 Oct 87) pp 55-57

[Article by V. A. Yatsenko, V. T. Zhadan, P. M. Gerashchenko, I. L. Shturgunov, and V. M. Kapsheeva, Ukrainian Scientific Research Institute of Special Steels]

[Abstract] An experimental study of hot-rolled Cr15 ball-bearing steel (0.98 pct C, 14.4 pct Cr, 0.29 pct Mn,

0.31 pct Si, 0.07 pct Cu, 0.031 pct Al, 0.07 pct S, 0.014 pct P) was made for the purpose of determining the dependence of its structure grid carbide size and properties (flexural strength) on the final rolling temperature, the percentage reduction in the last pass, and the cooling rate after the last pass. Specimens of this steel 110-120 mm long with a 20 mm square cross-section were heated to, and held for 60 min at, 1130-1150°C, then rolled in a 260 mill with 40 pct reduction in a single pass. They were subsequently transferred to a furnace and held here for 5-7 min at the temperature of the last pass, whereupon they were rolled again with 10, 20, 30 pct reduction per pass. Rolling was followed by air-cooling with fans in a fireclay brick container preheated to 500 or 600°C so that the rate of cooling of the innerlayers from 850 to 700°C could be varied over the 10-250°/min range. The carbide grid was measured on lengthwise-cut specimens after heat treatment by spheroidizing at 790°C for 3 hours, cooling to 730°C at 50°/h, holding at 730°C for 4 hours, heating to and quenching from 850°C, and tempering at 150°C. The flexural strength was measured on 50 mm long specimens with a 6 mm square cross-section. Evaluation of the data by the experiment planning method and regression analysis, this one involving three factors at three levels, has yielded the optimum rolling process parameters for this steel. The results were used for hot-rolling Cr15 ball-bearing steel strip in the 810 mill at the Novosibirsk Metallurgical Plant.

Promising Continuous Steel Casting Units

18420119 Moscow STAL in Russian No 1, Jan 89 pp 20-23

[Article by I. P. Shabalov, Central Scientific Research Institute of Ferrous Metallurgy, L. A. Smirnov, and A. F. Sharov, Ural Scientific Research Institute of Ferrous Metallurgy, and A. I. Mayorov, All-Union Scientific-Research and Planning-Design Institute of Metallurgical Machine-Building]

[Abstract] The authors report on the status of the research, development, and design work done at their respective institutes with regard to continuous casting and casting-rolling of steel (up to 12 grades) into strip and plate stock as well as blocks up to 80 x 90 mm² in cross-section. The next generation of continuous-casting machines will include those operating with conveyor belts, those with vertical casting and subsequent bending of ingots like those developed by the Thyssen GmbH (FRG), and horizontal ones with bilateral or unilateral extraction from a radical crystallizer. Experimental prototypes have been built for testing various methods of metal feed and extraction. The aim is to achieve reliable as well as efficient and economic production with minimum metal waste. Machines of the planetary-eccentric type such as the "Gorizont" can already be recommended for casting steel and subsequent rolling of 30-50 mm thick ingots into 5-6 mm thick strip.

UDC 669.295:621.785.3:548.4

Third Stage of Defect Annealing in Deformed Titanium

18420128 Sverdlovsk FIZIKA METALLOV I
METALLOVEDENIYE in Russian Vol 67 No 1, Jan 89
(manuscript received 13 Jul 87) pp 206-207

[Article by Ye. B. Klopikov, T. A. Pyzhova, and A.N. Semikhin, Moscow Engineering Physics Institute]

[Abstract] An experimental study of titanium was made by two structure-sensitive methods, internal friction and positron annihilation measurements, the third stage of defect annealing after plastic deformation being of interest. Both the mean life of positrons and Q^{-1} were measured in iodided 99.98 pct pure Ti. Specimens of the latter had been resmelted in an argon atmosphere in an electric-arc furnace, then rolled and annealed under vacuum. Their subsequent controlled plastic deformation to various strain levels up to 0.02 maximum was followed by isochronous annealings from each strain and then a 1 hour holding period at increasingly higher temperatures. A spectrometer with a 360 ps time resolution was used for lifetime measurement, the long-life component of the spectrum corresponding to positrons in a ^{22}Na -source. The results of these measurements indicate that the third stage of defect annealing is reached at temperatures within the 300-500 K range. Internal friction measurements have revealed that this stage consists of two substages, migration of interstitial impurity atoms occurring in the first and migration of vacancies occurring in the second. The next peak of relative Q^{-1} increment at close to 800 K belongs to the fourth annealing stage. References 6: 4 Russian, 2 Western.

UDC 621.78.72:669.14

Laser-Arc Treatment of Steels

18420110 Moscow METALLOVEDENIYE I
TERMICHESKAYA OBRABOTKA METALLOV
in Russian No 1, Jan 89 pp 13-15

[Article by L. N. Stenishcheva and Yu. N. Seleznev, All-Union Electrothermal Equipment Scientific Research Institute]

[Abstract] There is at present no well developed theory to describe laser-arc treatment, in which an object is exposed simultaneously to a laser beam and an arc discharge. Experiment planning methods can be used to construct an optimal system for the variation of the parameters which determine the mutual position of the laser spot and arc discharge for experimental purposes. This article presents the results of a study of the influence of the degree of focusing, laser beam movement speed and arc length on the hardness, width, thickness and structure of the laser-affected zone during laser-arc hardening of normalized type 45 steel. The laser-arc method of thermal hardening can produce hardened

layers 2-3.5 times thicker than with laser hardening alone while retaining high microhardness, hardened layers 4-6 mm wide and up to 1.0 mm thick while moving at 10 mm/s, or 3-4 mm wide and 0.4-0.6 mm thick when moving at 20-30 mm/s. Increasing the arc length from 2-5 mm has practically no influence on the geometry of the laser-affected zone. Defocusing the laser beam and increasing the speed are ineffective, reducing the level of hardness. References 3: 1 Russian, 2 Western.

UDC 620.193

Influence of Impurity Segregation at Grain Boundaries on Intercrystalline Corrosion of Austenitic Stainless Steels in Strong Oxidizers

18420087a Moscow ZASHCHITA METALLOV
in Russian Vol 24 No 6, Nov-Dec 88 (manuscript received 2 Sep 87) pp 899-911

[Article by O. V. Kasparova, Physical Chemistry Scientific Research Institute imeni L. Ya. Karpov]

[Abstract] The influence of various metallurgical factors on formation of impurity element segregations at grain boundaries in iron based alloys is studied. The significance of impurity segregations along the grain boundaries in intercrystalline corrosion of austenitic stainless steels is also noted. Phosphorus, silicon and carbon, as well as microscopic quantities of boron, most strongly decrease corrosion resistance in strongly oxidizing media. Increasing the purity of austenitic stainless steels with respect to P, Si, S and other impurity elements is a realistic means for improving their corrosion resistance in strong oxidizers such as media used in the production of dilute nitric acid. A positive effect can also be achieved by additional alloying using elements which tend to passivate the grain boundaries and by the addition of additives which extract harmful impurities from the grain boundaries. References 94: 28 Russian, 66 Western (3 in Russian translation).

UDC 669.14:537.37

Collapse of Cavities Near Inclusions in Steel Under Explosive Treatment

18420086 Moscow IZVESTIYA AKADEMII NAUK
SSSR: SERIYA METALLOV in Russian
No 6, Nov-Dec 88 (manuscript received 16 Jul 87)
pp 38-42

[Article by S. I. Gubenko, Dnepropetrovsk]

[Abstract] Following tensile testing of steel specimens at 20-1100°C, the central portion of the specimens was cut away and exposed to explosive impact by collision with a metallic plate, the collision pressure reaching 80-90 GPa, speed of deformation 100 s⁻¹, time of action 10⁻⁷-10⁻⁸ s. One group of specimens was examined after tensile deformation, another after tensile deformation

and explosive impact. Nonmetallic inclusions were identified metallographically, petrographically and by microscopic x-ray examination. The explosive loading changed the shape and dimensions of microscopic ruptures occurring near nonmetallic inclusions. Cavities formed in extension due to layer separation between an inclusion and the matrix sometimes partially or completely collapsed and were explosively welded. Brittle cracks in the inclusions showed no tendency to heal. Explosive welding changed the loading scheme and location of plastic rotation and shear near inclusions in the matrix, accelerated mass transfer and increased defect density, causing local heating of the matrix near inclusions. References 11: 10 Russian, 1 Western (in Russian translation).

Effect of Transversely Nonuniform Cooling on Transverse Variation of Strip Thickness

18420124a Moscow METALLURG in Russian
No 12, Dec 88 pp 30-31

[Article by K. N. Savranskiy, A. P. Paramoshin, S. N. Litvinenko, V. N. Karlov, and I. M. Khrebtov, Donetsk Scientific Research Institute of Ferrous Metallurgy and Cherepovets Metallurgical Combine]

[Abstract] Forced water-cooling of up to 2000 mm wide hot-rolled strip from 1000°C directly in the 4-roll stands of a 2800 mill was studied for a way to maximally reduce the transverse variation of strip thickness, some reduction of this variation already being attained by transversely nonuniform cooling. The transverse temperature drop without forced cooling was found to vary from 5°C in 19-25 mm thick strip to 15°C in 7.5-10 mm thick strip while the transverse variation of strip thickness under natural air-cooling was found to vary over the 0.14-0.42 mm range, depending on the nominal strip thickness and on the strip width as well as on the wear of the rolls. Accelerated cooling proved to be most effective in producing a transversely nonuniform cooling pattern further reducing that thickness variation. Implementation of this method at the Cherepovets Metallurgical Combine has reduced the thickness variation by up to 0.1 mm as well as the necessary water use rate, with a 210,000 rubles annual saving in production costs.

UDC 620.163.4:621.762:669.14.018.252

Strength and Fracture Characteristics of Tungsten-Free High-Speed Steels

18420108a Moscow STAL in Russian
No 11, Nov 88 pp 91-93

[Article by A. N. Polandopulo and Ko Men Chkhor, Leningrad Polytechnical Institute]

[Abstract] Comparative studies were performed of the strength and fracture characteristics of tungsten-free powder steels types M6F1-MP and M6F3-MP and ordinary steels Kh6M3F3, M3F2 and M5F3SYu. The specimens were forged, annealed at 840°C to a hardness of

220-240 HB, heated to 1140-1240°C in a barium chloride bath, hardened in NaOH at 500°C, cooled in air and tempered at 540°C, 3 times for 1 hour each, to a secondary hardness of 63-66 HRC. Residual austenite did not exceed 3.5-6.5 percent. The specimens were then ground and subjected to static bend testing with a concentrated load. The powder tungsten-free high-speed steels were found to have a fine-grain structure, fine-needle martensite and dispersed carbides with maximum strength. Ordinary metallurgical steels with 3 percent Mo show a tendency toward grain growth, formation of large-needle martensite and lower strength, with crystalline fractures and a greater variety of fracture micromechanisms. Increasing Mo content to 5 percent and adding more Si and Al increases the strength and creates more uniform fractures. The powder-based steels have greater brittle fracture resistance and reliability. References 10: all Russian.

UDC 621.762.4

Liquidation of Residual Porosity in Carbide Steels by Plastic Working

18420108b Moscow STAL in Russian
No 11, Nov 88 pp 93-95

[Article by V. K. Narva, N. S. Loshkareva, and D. P. Burba, Moscow Steel and Alloys Institute]

[Abstract] A study is made of the influence of the plastic deformation titanium carbide-steels on liquidation of residual porosity after sintering at the optimal temperature and at a temperature 50°C below the optimal temperature by plastic working. The steels studied contained 10, 30, 40 and 70 percent titanium carbide, the remainder being type Kh6V3M steel. Plastic working was by gasostatic pressing at 200 MPa, temperature 1350°C, for 30 minutes and hot deformation at 1000 and 1100°C with deformation rates of 2 and 50 mm/min. The results indicate that the steels can be plastically deformed to achieve complete elimination of residual porosity even in alloys sintered at a temperature less than the optimal temperature. References 2: both Russian.

621.771.2.004.18

Production of Rolled Products Differentiated by Strength Groups

18420079a Moscow STAL in Russian
No 10, Oct 88 pp 49-52

[Article by V. F. Kovalenko, E. I. Feldman, and L. F. Kuznetsov, Ukrainian Metallurgy Scientific Research Institute]

[Abstract] One of the ways to increase efficiency in use of rolled products is their selective supply on the basis of strength characteristics. A differentiated system for the production of rolled products by strength groups will make it possible to save metal without additional capital investments. Such a system was developed on the basis of proba-

bilistic-statistical methods for evaluating the quality of production. Specifications have been drawn up which provide for production of such products in two strength groups with a higher level of mechanical properties than under existing standards. Many measures for achieving this goal are discussed. For example, the chemical composition of steel is to be regulated at plants relative to the thickness of the rolled products. This has already made it possible to upgrade the quality of the delivered product, to broaden the range of thicknesses and increase production volume. The results of study of actual production differentiated by strength groups revealed that at 25 plants production increased by 24 percent or more between 1984 and 1987. Much remains to be done in improving quality, modernizing equipment and increasing production of a higher quality category, but significant strides have already been taken. References: 9 Russian.

UDC 621.771.07:621.791.92.004.6

Status of Technology and New Developments in Welding of Rollers

18420079b Moscow STAL in Russian
No 10, Oct 88 pp 66-68

[Article by V. I. Rybalka, candidate of technical sciences, and V. P. Masyk and Yu. P. Shevchenko, engineers, Ukrainian Metallurgy Scientific Research Institute]

[Abstract] Automated arc welding is the principal means used for restoring rollers. However, the currently employed procedures are in a number of ways ineffective. There is a lack of thermal processing equipment and instrumentation for checking the heating of the rollers, the hardness of the weld metal and its continuity and there is no specialized apparatus for restoring rollers weighing up to 4 tons. The equipment currently being used for the thermal processing and heating of rollers and its deficiencies are described. Specialists at a number of institutes are working to eliminate these problems. The difficulties involved in solving these problems are defined and means to overcome them are discussed. The proposed technology ensures that the weld metal will be free of pores, pits and cracks. Its use will make it possible to increase the durability of the shaping elements by a factor of 1.2-2. Research is in progress on the use of plasma welding for restoring rollers. This would be a considerable improvement over arc welding, but a number of problems remain unsolved.

UDC 621.774:35.016.3:669.14.018.8

Development of Production of High-Quality Cold-Worked Pipes of Corrosion-Resistant Steels

18420079c Moscow STAL in Russian
No 10, Oct 88 pp 75-77

[Article by V. F. Frolov, candidate of technical sciences, All-Union SRTI]

[Abstract] The technological process of production of cold-worked pipes usually provides for primary (rolling,

drawing) and auxiliary (thermal and chemical processing, finishing) operations and equipment with virtually no connection between the two. This has naturally resulted in a low efficiency in operations and is cost-ineffective. This aggravates the fact that the production of corrosion-resistant pipe and other products is technologically already deficient by a number of other criteria. There have been no significant improvements in the production technology during the last 25-30 years: there has been no progress in quality, no reduction in labor inputs or power consumption. The system used at the present time is described, with particular attention to the highly inefficient techniques used in the transport and storage of pipe. It is stressed that improvement in any operation, even one of the greatest importance, without improvement of all other operations, fails to increase production. However, it is now clear how the efficient production and handling of high-quality pipe is possible in all its aspects. A number of ways in which this can be achieved are discussed. References 3: 1 Russian, 2 Western.

UDC 669.184.244.66:65.011.56

Automation of Process of Discharge of Converter Gases Without Afterburning

18420079d Moscow STAL in Russian
No 10, Oct 88 pp 108-111

[Article by Yu. D. Grigoryan, Yu. Ya. Treyster, L. N. Kanaplin, A. P. Shchegolev, and Yu. M. Uspenskiy, Chermetavtomatika Scientific Production Association and Cherepovets Metallurgical Combine]

[Abstract] All steel mill converters now under construction are being supplied with systems for regulating the discharge of converter gases without afterburning. However, for organizational reasons in some places this is being done only partially, thereby defeating the goals which have been set. The various aspects of this problem are discussed, such as the reconstruction of existing facilities and the technical difficulties involved in perfecting such systems. At the Cherepovets Metallurgical Combine the Chermetavtomatika Scientific Production Association is continuing work on the regulated discharge of converter gases without afterburning and with its subsequent utilization. The proposed system frees the operator from distracting tasks, automates the process of discharge of converter gases and ensures automatic maximal trapping of converter gas. Devices are incorporated to ensure safety under emergency conditions. The design of this system is shown in a diagram (28 components are identified), which serves as a basis for the textual description. The new system will be effective in safeguarding the environment. Figure 1; references: 5 Russian.

UDC 662.741.3:620.17:18

Production of Low-Reactivity Coke From Donets Coal

18420097a Dnepropetrovsk *METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST: NAUCHNO-TEKHNICHESKIY I PROIZVODSTVENNYY SBORNIK* in Russian No 4, Oct-Dec 88 pp 13-15

[Article by I. I. Kasyan, A. I. Bondarenko, S. V. Savchenko, V. M. Antipov, I. A. Turik, and Z. K. Glazkova, Donetsk Scientific Research Institute of Ferrous Metallurgy and Donetsk By-product Coke Plant]

[Abstract] Comparative studies of the physical-mechanical and physical-chemical properties of coke obtained under various coking conditions at the Yasinovka, Avdeyevka, Donetsk and Cherepovets plants were performed in order to determine the factors forming the reactivity of the coke. Coke from the Yasinovka plant differed significantly from that of the Avdeyevka, Donetsk and Cherepovets plants, both in strength and in chemical properties. The Cherepovets plant coke was placed in first position in terms of mechanical strength, reactivity, low flammability and resistance. The Cherepovets plant coke had the least pore surface and specific volume while Yasinovka plant coke had the greatest. Charges of the best Donets coal were used to produce coke close in its physical and chemical characteristics to the low-reactivity coke of the Cherepovets Metallurgical Combine. Introduction of some additional Kuznetsk coals provides a reserve for improving quality still further. It is recommended that southern by-product coke plants begin to utilize this resource for the production of low-reactivity coke. References 4: all Russian.

UDC 669.162.266.24.045.3

Methods of Preserving Liquid Cast Iron Temperature Outside Furnace

18420097b Dnepropetrovsk *METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST: NAUCHNO-TEKHNICHESKIY I PROIZVODSTVENNYY SBORNIK* in Russian No 4, Oct-Dec 88 pp 20-22

[Article by L. Yu. Nazlyuta, G. Z. Gizatulin, V. S. Kharakhulakh, A. M. Ovsyannikov, V. A. Rubtsov, and V. I. Goryachev, Zhdanov Metallurgical Institute and Combine imeni Ilich]

[Abstract] Heat losses of cast iron in the ladle can be decreased by increasing ladle capacity and filling, reducing iron transportation time and forming insulating layers on the surface of the melt. The last method is particularly interesting and has not been sufficiently studied in the Soviet Union. At the combine imeni Ilich, filling of ladles was increased by 10-15 percent and melt

surfaces were insulated by covering with secondary carbon-containing materials at 2.5-3.0 kg/t of iron. This increased the temperature of the liquid iron by 20-35°C. Reference 1: Russian.

UDC 621.791.72.052:669.14:620.18

Influence of Repeated Electron-Beam Welding Passes on Properties of Welded Joints in Type 20 and Type 08Kh18N10T Steels

18420092 Kiev *AVTOMATICHESKAYA SVARKA* in Russian No 10, Oct 88 (manuscript received 13 Jan 87; in final form 2 Nov 87) pp 43-45

[Article by R. S. Yusupov, A. Ye. Stronskiy, candidates of technical sciences, and V. I. Miskov, engineer, Irkutsk Scientific Research Institute of Chemical Machine Building]

[Abstract] The influence of repeated remelting of the seam metal by an electron beam on the structure and properties of welded joints of types 20 and 08Kh18N10T steel is studied. Experiments were performed on tubular welded specimens 140×40 and 170×40 mm in diameter following machining to a roughness of $R_a 6.3 \mu\text{m}$. Mechanical testing was performed on a tensile testing machine and pendulum impact tester. It was found that repeated passes of the electron beam changed the mechanical properties of the welded joints in type 20 steels, particularly impact toughness. After the first repeated pass, the impact toughness of the seam reached that of the base metal; after a second repeated pass it was lower than the permissible values. The mechanical and anticorrosion properties of welded joints in type 08Kh18N10T steel were practically unchanged even after the second repeated pass without intermediate cooling. References 2: both Russian.

UDC 669.779:620.186.2:539.56

Role of Grain-Boundary Phosphorus Segregations in Austenite in Development of Intercrystalline Steel Brittleness After Hardening and Tempering

18420099b Sverdlovsk *FIZIKA METALLOV I METALLOVEDENIYE* in Russian Vol 66 No 4, Oct 88 (manuscript received 2 Mar 87; in final form 14 Oct 87) pp 792-798

[Article by V. I. Sarraf, G. A. Filippov and V. R. Knyazeva, Institute of Metal Science and Metal Physics; Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin; Tula Scientific Research Institute of Ferrous Metals]

[Abstract] Studies are performed to answer the following questions: is the influence of segregation impurity enrichment of initial austenite grain boundaries formed during heating of steel for hardening retained as intercrystalline brittleness during tempering; is segregation impurity enrichment of austenite grain boundaries a sufficient condition for intercrystalline brittleness developing during tempering? Testing of hydrogen embrittlement of steel after tempering at various temperatures can

be used to estimate the degree of segregation impurity enrichment of grain boundaries as a function of tempering temperatures. Studies were performed on 20 KhG steel, containing (in percent) 0.23 C, 1.0 Cr, 1.07 Mn, 0.007 S, 0.027 P, austenitized by heating to 1000°C, holding for 15 minutes and hardening in water, or by heating to 1000°C, holding for 15 minutes, cooling to 860°C, holding at this temperature for 15 minutes and hardening in water. It is found that segregation impurity enrichment of grain boundaries alone is insufficient for the development of intergrain fracture. This requires additional factors: internal microstresses or decomposition of the solid solution. The embrittling factor in reversible tempering brittleness is carbide formation on the grain boundaries. These additional factors, plus harmful impurity segregations at the grain boundaries, weaken the boundaries to cause intercrystalline fracture. References 12: 9 Russian, 3 Western.

Change in Technology for Reduction-Alloying of Sv08G2S Steel

18420076b Moscow METALLURG in Russian
No 10, Oct 88 pp 42-43

[Article by A. F. Sarychev, P. A. Epp, A. M. Dobraya, I. P. Galibuzov, and V. S. Klimov, Magnitogorsk Metallurgical Combine]

[Abstract] There have been a number of deficiencies in the reduction-alloying of Sv08G2S steel which can be eliminated by a different, more cost-efficient, technology. With the introduction of purging of the metal by argon in the ladle, which accelerates the dissolving of admixtures, the possibility has emerged for testing silicomanganese, which is not in short supply, for the alloying of steel, rather than medium-carbon ferromanganese, a deficit raw material. The experimental technology ensures the same uniformity of chemical composition with respect to silicon and manganese as the use of medium-carbon ferromanganese without purging by argon. The chemical composition of the experimental and comparison metals is tabulated and the frequency distribution of the mechanical properties of the metal smelted under the experimental and current technologies is compared. When alloying the metal with silicomanganese there must be a lower carbon content prior to reduction. The use of silicomanganese in combination with purging of the metal by argon in the course of tapping the melt ensures a reduction in the expenditure of ferroalloys by 3.34 kg/ton and a significant cost reduction.

UDC 669.15-194.55:539.4.01/019

Hardening of Heterophase Martensitic Aging Steels During Plastic Deformation

18420077b Moscow IZVESTIYA AKADEMII NAUK
SSSR: SERIYA METALLY in Russian
No 5, Sep-Oct 88 (manuscript received 5 May 87)
pp 110-114

[Article by S. V. Grachev, A. S. Sheyn, S. V. Pavlova, and S. V. Smirnov, Sverdlovsk]

[Abstract] A study was made of the changes in structure and properties transpiring during the deformation of

heterophase martensitic aging steels of two alloying systems having, accordingly, a different phase composition. A study was made of three martensitic aging steels on a Fe-Cr-Ni base, additionally alloyed with cobalt, molybdenum and titanium. Two of them had a two-phase austenitic-martensitic structure but a substantially different quantitative ratio of phase components after hardening. In the composition of the third, in addition to these components, δ -ferrite was observed after hardening from 1050-1200°C. It was found that the deformation of heterophase Ni-Cr-Co-Mo steels at room temperature exerts a different influence on the law of (γ to α)-transformation depending on the phase composition of the steels. In austenitic-martensitic steels this transformation develops with degrees of deformation greater than 20 percent, but in austenitic-martensitic-ferrite steels martensite transformation begins at the onset of deformation. Deformation of the investigated steels by upsetting at a temperature of -196°C is accompanied by considerably less hardening and intensity of the occurrence of the deformational (γ to α)-transformation than the similar effect at room temperature. Deformation at a temperature -196°C intensifies the process of subsequent aging of steel with both an austenitic-martensitic structure and with an austenite and δ -ferrite structure. References 6: all Russian.

UDC 669.14.018.29

Influence of Microregulating Additives and Admixtures on Resistance of Steels for High-Strength Bolts to Delayed Corrosion Fracture

18420077f Moscow IZVESTIYA AKADEMII NAUK
SSSR: SERIYA METALLY in Russian
No 5, Sep-Oct 88 (manuscript received 26 Feb 87)
pp 176-181

[Article by L. I. Gladshcheyn, V. M. Goritskiy, N. A. Yevtushenko, V. I. Sarraf, and G. A. Filippov, Moscow]

[Abstract] A study was made of the influence of small additions of niobium, titanium and boron and of the content of sulfur and phosphorus on resistance to cracking and the tendency to delayed fracture of steels employed in fabricating high-strength bolts. The steels 40Kh, 20Kh2NM, 20Kh2NMTR and 20Kh2NMTRB were investigated. The introduction of titanium (0.029-0.078 percent), niobium (0.025-0.049 percent) and boron (0.0015-0.0044 percent) to the improved steel 20Kh2NM (with a lath martensite and bainite structure) increases the resistance to crack generation and propagation due to corrosion caused by stressed conditions and delayed fracture under conditions of the saturation of the steel with hydrogen. Large (3-15 μ) particles of titanium carbonitrides exert a dual influence on fracture resistance, causing a decrease in resistance to brittle fracture during tests in air and increasing resistance to delayed fracture under conditions of exposure to a corrosive medium and hydrogen. A decrease in sulfur

content (0.027-0.005 percent) and phosphorus content (0.026-0.005 percent) in 20Kh2NMTRB steel increases resistance to corrosion under stress and increases the time to destruction and the rate of propagation of a stable crack in a hydrogenating medium. References 8: 7 Russian, 1 Western.

UDC [621.791.052:539.38/.4.014]:621.7.044.2.01

Stress Fields and Deformations in Surface Explosive Hardening of Metal Structure Welded Joints

18420096B Kiev AVTOMATICHESKAYA SVARKA in Russian No 9 Sep 88 (manuscript received 9 Feb 87; in final form 11 Jun 87) pp 21-23

[Article by V. G. Petushkov, doctor of technical sciences, Yu. I. Fadeyenko, candidate of physical-mathematical sciences, V. V. Yakubovskiy, candidate of technical sciences, V. M. Pervoy, and V. V. Borisenko, engineers, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences]

[Abstract] It is difficult to study the fields of elastic-plastic deformation following explosive metal surface hardening. The method of Moire bands can allow visualization, qualitative and quantitative analysis of the distribution of stresses and strains. This article presents a study of the fields of elastic-plastic stresses and strains and the geometry of the plastic deformation known following surface hardening of welded joints by a powerful explosive charge, though not powerful enough to damage the surface. Studies were performed on type 14Kh2GMR steel with yield point 600 MPa. The Moire bands formed in a 1/20 mm-thick test strip were used to study the fields of stress and strain following the explosions. The data indicate possible elastic-plastic deformation of high-strength steels to a depth of up to 22 mm in the process. The use of linear explosive charges generates residual compressive stress on both front and back surfaces of the specimens beneath the explosive charge. Figures 4, references 4: Russian.

UDC 669.15:(537.311.3+536.2.022):53.096

Temperature Variation of Resistivity and Heat Conductivity of Certain Steels

18420069a Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 66 No 2, Aug 88 (manuscript received 8 Jan 87; in final form 16 Mar 87) pp 273-277

[Article by A. I. Veynik, G. V. Markov, S. K. Ginsburg, and E. B. Matulis, Physical Technical Institute, Belorussian Academy of Sciences]

[Abstract] Resistivity and heat conductivity were studied in the 25-1100°C temperature interval by a method based on analysis of the thermal balance equations for a single specimen in a vacuum chamber with a temperature difference created between the ends of the specimen

and a constant electric current transmitted through the specimen. Type 45 steel was studied after hardening and high tempering, type 08N6G4ML steel in the hardened and intensively aged (10 hours at 550°C) states and type 12DN2FL and 40Kh13 steels after hardening and high tempering. Some of the 40Kh13 steel specimens were annealed. Type 10Kh18N10T steel was studied after austenitization and cooling in water. It was found that the heat conductivity of carbon and low-alloy steels is determined by the electron component, the phonon component being insignificant. Heat conductivity of alloy steels was found to increase with increasing temperature between 27 and 1100°C as a result of the significant fraction of phonon conductivity, which is comparable to the electron component. Structural changes in the alloy steels primarily influence the phonon component of heat conductivity. Electrical resistivity was approximately the same for all steels tested except 10Kh18N10T, following the equation $aT^2 + bT + c$ up to the Curie point, then becoming practically linear. In type 10Kh18N10T steel, the variation of electrical resistivity as a function of temperature shows no bends. Resistivity increases with increasing alloying of the steels at 27°C. At 900°C all the steels have approximately the same resistivity. References 11: all Russian.

UDC 669.15'24-194:669-172:620.181

Influence of Reversible γ - α Transitions on Martensite Transformation and Crystalline Structure of High-Nickel Steel

18420069c Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 66 No 2, Aug 88 (manuscript received 7 Apr 86; in final form 4 Mar 87) pp 318-322

[Article by V. I. Bondar, V. V. Girzhon, and V. Ye. Danilchenko, Metal Physics Institute, Ukrainian Academy of Sciences]

[Abstract] This article continues previous studies of the conditions of the development of processes determining the recrystallization of austenite and alteration of the crystalline structure of martensite formed in the reversed γ phase. Studies were performed on single crystal specimens of type 50N24 steel made in an induction furnace and hardened in cold water from 1373 K. X-ray studies were performed at low temperatures. Full recrystallization under the influence of repeated reversible γ - α transformations was observed only with the slight stabilizing influence of these transformations on the austenite. Decreasing the heating rate caused more intensive development of disorientation of reversed austenite sections, causing recrystallization to be completed with a smaller number of transformations. Slow heating resulted in full stabilization of austenite in a single γ - α cycle. Rapid heating at 60 K/s had no significant stabilizing influence even after 100 γ - α cycles. Full dissolution of carbon in the reversed austenite occurred only with rapid heating. At 0.08 K/s, repeated carbon dissolution was incomplete

due to its irreversible attachment to lattice section defects upon decomposition of the martensite. References 11: 10 Russian, 1 Western.

UDC 669.15'24'295-194:620.186.1

Dissolution of Spherical and Plate-Like Intermetallides in Fe-Ni-Ti Austenite Alloys During Cold Plastic Deformation

18420069d Sverdlovsk FIZIKA METALLOV I

METALLOVEDENIYE in Russian

Vol 66 No 2, Aug 88 (manuscript received 10 Mar 87)

pp 328-338

[Article by V. V. Sagaradze, S. V. Morozov, V. A. Shabashov, L. N. Romashev, and R. I. Kuznetsov, Metal Physics Institute, Urals Department, USSR Academy of Sciences]

[Abstract] A study is made of the dissolution of coherent dispersed γ' -phase particles of various sizes and large η -phase plates during cold plastic deformation of austenitic N35T3 alloy containing (in mass percent) 35.0 nickel, 2.6 titanium, less than 0.02 carbon, remainder iron, hardened from 1100°C and aged at 500-700°C for up to 10 hours. Cold plastic deformation caused dissolution of the γ' -phase particles in the γ matrix and dissolution of η -phase plates, intensifying with the degree of deformation, particularly with shear under pressure. The deformation dissolution is explained by processes causing breakup of the crystals by dislocations, grinding and pseudomechanical mixing during strong plastic deformation by shear and rotation. References 19: 13 Russian, 6 Western.

UDC 669.15'74'292-194:(538.22+539.4.015)

Structure, Mechanical and Magnetic Properties of High-Strength 60G20F2 Austenite Alloy

18420069h Sverdlovsk FIZIKA METALLOV I

METALLOVEDENIYE in Russian

Vol 66 No 2, Aug 88 (manuscript received 16 Mar 87)

pp 381-386

[Article by M. N. Mikheyev, M. M. Belenkova, G. A. Pegushina, and R. N. Vitkalova, Metal Physics Institute, Urals Department, USSR Academy of Sciences]

[Abstract] The γ -stabilized alloy 60G20F2 was investigated to study processes of formation of its strength and ductility properties upon deformation and aging and to determine the optimal parameters for hardening treatment, considering austenite stability. The steel studied contained, in percent, 0.6 C, 20 Mn, 2 V. Specimens hardened from 1150°C were hydraulically extruded, aged at 500-800°C for 1 hour, then strength tested. Diffraction electron microscopy of thin foils was used to study the structure of the specimens and the magnetic susceptibility was measured. Aging was found to decrease the stability of the manganese austenite. The decrease in carbon content in the γ -solid solution upon

formation of vanadium carbides caused development of martensitic ϵ and α phases. Transition of the austenite to the metastable state during aging resulted in development of the α phase during plastic deformation of specimens aged at high temperatures. Magnetic permeability was low. Good mechanical properties and low magnetic permeability were achieved by hardening from 1150°C, hydraulic extrusion at 55 percent deformation and aging at 500°C for 1 hour. References 8: all Russian.

UDC 669.14.018.44:539.4.015

Influence of Structure of Dispersion-Hardening Heat-Resistant Steel on Avalanche Crack Growth Under Creep Conditions

18420069i Sverdlovsk FIZIKA METALLOV I

METALLOVEDENIYE in Russian

Vol 66 No 2, Aug 88 (manuscript received 16 Dec 86; in

final form 14 Apr 87) pp 392-395

[Article by V. I. Gladshteyn, T. P. Kuznetsova, N. L. Sherbaum, and M. M. Melamed, Heat Engineering Scientific Research Institute imeni F. E. Dzerzhinskiy, Moscow]

[Abstract] A study was performed to accumulate data on the peculiarities of the avalanche failure mechanism and to attempt to explain the results by analyzing the contribution of various hardening factors. The influence of structure on fracture toughness was studied on specimens of type 15Kh1M1FL steel, two batches as delivered and two after operation at 560°C, pressure 13 MPa, for 90,000 and 105,000 hours. Specimens from two batches of type 20KhMFL steel with lower content of molybdenum, chromium and vanadium were also studied, as delivered and after 107,000 hours of use. Long-term strength tests of 5-6 $\cdot 10^3$ hr at 565°C were undertaken. The fracture zone in both types of steel as delivered showed clearly cup-like structure. After long-term loading under usage conditions, the nature of fracture changed, showing flat flakes, rather large facets with signs of microscopic deformation significantly less than in the metal as delivered. The contribution of various mechanisms of hardening was estimated for each type of steel as delivered and after use. Hardening due to small particles decreased with use by a factor of 3-4, which tended to deflect the trajectories of cracks away from large carbides. The major reason for the difference in fracture mechanisms before and after aging was an increase in the distance between large particles and the relative decrease in the contribution of smaller particles and dislocations to hardening. References 7: 4 Russian, 3 Western (in Russian translation).

UDC 535.211

Laser-Heat Treatment of High-Speed Tool Steel With Surface Melting

18420028b Moscow FIZIKA I KHIMIYA OBRABOTKI

MATERIALOV in Russian No 4, Jul-Aug 88 pp 63-57

(manuscript received 1 Oct 87) pp 63-67

[Article by A. N. Bekrenev, G. G. Gladush, S. V. Drobnyazko, and V. V. Protnov, Kuybyshev]

[Abstract] Processes including surface melting which occur during surface laser-heat treatment of high-speed

tool steel are analyzed on the basis of a theoretical thermophysical model and experimental data. The experiment was performed on pearlitic and martempered specimens of R-9Co5 steel, using a Kvant-12 pulsed laser and an LTN-102V continuous-wave laser or a periodically pulsed CO₂-laser for heat treatment. Both the mean surface temperature and the rise of surface temperature produced by the last pulse of the CO₂-laser were determined on the basis of heat-affected zones, the melting point of this steel known to be 1300 deg C and the temperature of ferrite austenitization in the originally pearlitic structure known to be 910 deg C. The temperature at points in a heat-affected zone moving across the laser beam was calculated as a function of the space coordinate and time according to an universal expression applicable to heat treatment with any laser. Microstructural examination and microhardness measurements revealed formation of a "white zone" during laser treatment, indicating dissolution of carbides at temperatures from 950 deg C to 1100 deg C in an originally pearlitic structure and up to 1000 deg C in an originally martensitic structure. They also revealed a zone of higher microhardness, evidently formed by dissolution of carbides at temperatures at least 100 deg C higher than the upper "white zone" temperature for each structure. References 21: 19 Russian, 2 Western (1 in Russian translation).

UDC 621.375.669.14

Laser-Plasma Treatment of Tool Steels

18420028c Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 4, Jul-Aug 88
(manuscript received 10 Apr 87) pp 79-83

[Article by A. A. Uglov, B. S. Medres, A. A. Solovyev, B. K. Zuyev, and I. L. Skryabin, Moscow]

[Abstract] An experimental study was made concerning the case hardening of high-speed tool steels and forging tool steels by a combination of surface laser treatment and nitriding. Specimens of R-18, R-6Mo5, and R-12V2Co8Mo3 steels inside a nitrogen chamber were treated with a GOS-1001 laser emitting pulses of 260 J energy and 1 ms duration, the beam being focused on a spot 0.25 mm in diameter, after prior standard heat treatment and with the target surface polished to a class-8 finish. The specimens were 5 mm thick and square with a 10x10 mm² surface areas. Metallographical examination after laser treatment revealed a case surface consisting of two distinct zones: a plasma-affected zone at the center surrounded by a laser-plasma action zone. The nitrogen pressure was varied over the 3-7 MPa range, the radius of the plasma-affected zone increasing almost linearly with the pressure and the width of the laser-plasma action zone changing non-monotonically with a dip to a minimum under some intermediate pressure (5 MPa for R-18 steel). Microhardness measurements revealed a slightly etchable gray layer 160-220 kgf/mm² harder than the parent material between an unetchable white superficial layer 100-120 kgf/mm² softer than the parent material and a highly

etchable deeper layer also 100-120 kgf/mm² softer than the parent material, each layer of R-18 steel being approximately 0.130 mm thick. Laser mass-spectrometry under vacuum revealed a redistribution of nitrogen in both zones. Phase analysis in a DRON-3 x-ray diffractometer revealed Fe N and Fe N nitrides at the surface. References 9: all Russian.

UDC 535.211

Formation of Temper Zone During Case Hardening of Steel by Scanning Laser Beam

18420028g Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 4, Jul-Aug 88
(manuscript received 9 Dec 87) pp 139-140

[Article by G. F. Antonova and S. F. Moryashchev, Moscow]

[Abstract] An experimental study of case hardening of steel with a scanning laser beam was made for the purpose of determining how to prevent formation of parallel temper zones in the process. Since these zones are formed along the overlap of adjacent tracks of the laser beam sweeping the steel surface, as a result of second heating to a temperature below the austenitization range, prevention of this effect requires essentially that the treatment be faster than the cooling. The cooling time was determined for St45 carbon and 75Mn alloy steels under treatment by a LT-1 continuous-wave CO₂-laser at a radiation power level of 1 kW, the steel surface being coated with a mixture of iron oxides so as to ensure better absorption of radiation and being treated at a rate of 1.26 cm/s. Subsequent tests were performed on a shaft made of St45 carbon steel and 18 mm in diameter, rotating at a speed of 1 rps while moving forward at a velocity of 1.2 mm/s under the same laser with the radiation power now varied over the 0.8-2 kW range. Neither surface etching nor microhardness measurements after treatment with 2 kW radiation revealed any temper zones, while distinct temper zone were found to have been formed during treatment with 1 kW radiation power. References 4: all Russian.

UDC 669.14.018.583:538.22:621.77.016.2

Thermomechanical Treatment of Electrical Steels With Loads in the Area of Elastic Deformation

18420040c Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 66 No 1, Jul 88
(manuscript received 24 Dec 86; in final form 13 Mar 87) pp 119-125

[Article by V. A. Lukshina and I. Ye. Startseva, Metal Physics Institute, Urals Department, USSR Academy of Sciences]

[Abstract] Nontextured hot-rolled steels with 1.2, 2.6 and 4.3 wt. percent Si were used to study the behavior of magnetic properties under the influence of thermomechanical treatment as a function of silicon content,

carbon content, low-temperature annealing, previous thermomechanical treatment, surface oxidation and the presence of an active insulating coating. It was found that the effectiveness of thermomechanical treatment increases with increasing silicon content and after long-term, low-temperature annealing. Internal stresses in the material caused by the presence of carbides with increasing carbon content, surface oxidation, or application of an active coating to the surface, decreased the effectiveness of thermomechanical treatment. Similar results were obtained for thermomagnetic treatment. References 6: 5 Russian, 1 Western.

UDC 669.15'24'779'781:669-151.6:548.5

Influence of Heating Rate on Grain Size and Crystallization Kinetics of Amorphous Alloy $\text{Fe}_{40}\text{Ni}_{40}\text{P}_{14}\text{B}_6$

18420040e Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 66 No 1, Jul 88 (manuscript received 10 Dec 85; in final form 22 Apr 87) pp 169-177

[Article by V. P. Naberezhnykh, A. I. Limanovskiy, V. I. Tkach, L. V. Kuksha, and V. Yu. Kameneva, Donetsk Physical Technical Institute, Ukrainian Academy of Sciences]

[Abstract] A study is made of the crystallization kinetics of metallic glass $\text{Fe}_{40}\text{Ni}_{40}\text{P}_{14}\text{B}_6$ at $2 \cdot 10^{-2}$ -16 K/s to determine the influence of heating rate on the structure of the alloy and provide a theoretical interpretation of the phenomena observed. Approximate analytic expressions were produced within the framework of the Kolmogorov model for the density of grains, taking hardened seeds into account. It is difficult to apply these expressions to a description of the crystallization kinetics of a specific material, due to the unknown values of many constants and their temperature variation. The necessary data were obtained by comparing theoretical and experimental results and are presented in explicit form in two equations. Increasing the heating rate in the range studied causes an increase in the temperature from 653 to 733 K and a change in the mean diameter of two-phase colonies formed. The analytic expressions obtained for the temperature variation of mean diffusion coefficient and crystal growth rate agree satisfactorily with the experimental data of other authors. Hardened seeds are shown to have no influence on the kinetics of crystallization of the glass. References 16: 3 Russian, 13 Western (1 in Russian translation).

UDC 669.15'74-194:(539.386+539.89):620.181

Structural Transformations of High-Manganese Austenitic Steels Upon Shear Deformation Under Pressure

18420098a Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYA in Russian Vol 66 No 3, Sep 88 (manuscript received 18 Apr 86; in final form 14 Mar 88) pp 563-571

[Article by V. A. Teplov, L. G. Korshunov, V. A. Shabashov, R. I. Kuznetsov, V. P. Pilyugin, and D. I. Tupitsa, Metal Physics Institute, Urals Department, USSR Academy of Sciences]

[Abstract] A study is made of structural transformations upon great deformation by shear under pressure in high-manganese steels of the following types and compositions, in mass percent: 110G13 (1.2 C, 13.44 Mn); 70G11 (0.71 C, 10.1 Mn); 120G4 (1.12 C, 4.3 Mn); G40 (40.5 Mn). A number of Fe-Mn-C alloys containing 0.02-1.4 percent C and 12-14 percent Mn, not over 0.3 percent silicon, and 0.02 percent sulfur and phosphorus, were also tested. Shear deformation of G40 and 70G11 steels caused intensive development of martensitic γ - ϵ transformation. In 120G4 steel, martensitic γ - α transformation was observed. Type 110G13 (Hadfield) steel retains its austenitic structure when deformed under a pressure of 6-16 GPa to true deformation $\epsilon=8.4$. The microhardness of the steel reaches 9-10.5 GPa. At $\epsilon=8.2$ or more, an ultrafine crystalline structure is formed with a crystal size of 0.01 μm . The great hardening of 110G13 steel results from the formation of many dislocations, twins and packing defects. References 16: 10 Russian, 6 Western.

UDC 669.15'26'74-194:669.112.227.346.2

Martensite Transformation Kinetics of Transition-Class Carbon-Manganese Austenitic Steel Upon Cooling and Deformation

18420098b Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYA in Russian Vol 66 No 3, Sep 88 (manuscript received 21 Jan 87; in final form 14 Apr 87) pp 578-584

[Article by M. A. Filippov, V. Ye. Lugoviykh, Ye. S. Studenok, and M. Ye. Poptsov, Urals Polytechnical Institute imeni S. M. Kirov]

[Abstract] Results are presented from a study of the position of the temperatures of the onset of martensitic transformations upon deformation M_d and cooling M_c , and the kinetics of martensitic transformations upon cooling and plastic deformation of transition-class manganese steels containing 0.5-1.0 percent C and 0-8 percent Cr. The transformations were found to develop athermally or isothermally depending on the chemical composition and cooling rate. As manganese content increases and carbon content decreases, the tendency toward isothermic transformation increases. Increasing carbon content increases the effectiveness of alloying elements in decreasing M_c , manganese being 2-3 times stronger than chromium in this respect. Martensitic transformations develop from γ through ϵ to α' phases, forming ϵ and α' crystals up to 50-60 percent following 30 percent compressive deformation. Increasing chromium and manganese content increases stability of austenite upon deformation. Increasing carbon content to 0.7-0.8 percent decreases the intensity of α -martensite formation. The steels are divided into three groups based on carbon content, increasing carbon content corresponding to more rapid development of deformation martensite up to 0.7-0.9 percent C, after which it decreases. References 10: 9 Russian, 1 Western.

UDC 620.196

Nature of Intercrystalline Corrosion and Possibility of Increasing Corrosion Resistance of Ni-Mo Alloys by Means of Inhibitors

18420130a Moscow ZASHCHITA METALLOV in Russian Vol 25 No 1, Jan-Feb 89 (manuscript received 22 May 86) pp 36-47

[Article by T. Ye. Tsenta, V. M. Knyazheva, T. V. Svistunova, Ya. M. Kolotyarkin, and D. S. Zakharin, Physical Chemistry Scientific-Research Institute imeni L. Ya. Karpov and Central Scientific-Research Institute of Ferrous Metallurgy imeni I. P. Bardin]

[Abstract] Corrosion tests were performed on four Ni-Mo alloys: NiMo10, NiMo20, NiMo26 and NiMo28 smelted in an open induction furnace, as well as NiMo26 smelted in a vacuum furnace. Specimens in the form of disks 24 mm in diameter cut from 2 mm thick strip were heat treated under vacuum by quenching from 1050-1200°C in water and subsequent tempering at 600, 700, 800°C for 1, 10, 100 h at each temperature. Their surface was ground to a class-8 finish for corrosion tests. For electrochemical measurements their surface was cleaned with successively finer emery paper down to grade M20. Corrosion tests were performed by immersion for 200 h in boiling azeotropic 21 pct HCl solution, one series without additives and one series with acetylene alcohol (0.5 wt.pct primary propargyl alcohol or 0.4 wt.pct secondary propargyl alcohol, the latter in 5 pct ethanol solution) as inhibitor. Measurements were made in a pure nitrogen atmosphere inside a hermetic cell with three electrodes and a partition between cathodic and anodic regions. Cathodic and anodic polarization curves were plotted potentiodynamically with a sweep of 0.9 V/h. Highly sensitive gamma-spectroscopy made it possible, with the aid of specially prepared radioisotopic ^{65}Ni and ^{99}Mo tracers, to monitor the kinetics of Ni and Mo dissolution by simultaneously determining both Ni and Mo contents in the solution. Metallographic examination revealed intercrystalline corrosion, its principal cause evidently being molybdenum depletion at grain boundaries. A comparison with data on intercrystalline and general corrosion of stainless steels such as Cr17 and Cr18Ni9 indicates that the effectiveness of inhibitors increases with decreasing Mo content in the alloy. Considering that the corrosion potential of Ni-Mo alloys is sufficiently negative for intercrystalline corrosion to proceed at a slow pace, the authors recommend etching potentiostatically at a sufficiently positive potential or stabilizing such a potential by adding an oxidizer to the solution for accelerated corrosion testing of these alloys. References 17: 14 Russian, 3 Western.

UDC 620.193.4

Corrosion Resistance of Sintered TiC-Fe-Cr Hard Alloys and Its Effect on Their Corrosive-Abrasive Wear

18420130c Moscow ZASHCHITA METALLOV in Russian Vol 25 No 1, Jan-Feb 89 (manuscript received 22 May 87, after revision 8 Dec 87) pp 107-111

[Article by V. A. Kallast and Ya. P. Kyubarsepp, Tallinn Polytechnical Institute]

[Abstract] In a search for hard powder alloys with steel binder resistant to atmospheric corrosion and to corrosive-abrasive wear, TiC-Fe-Cr powder alloys containing 33-60 pct TiC and up to 25 pct Cr were produced by the solid-phase sintering process with 19.3 pct bound carbon and 0.71 pct free carbon in the TiC component. Bar specimens 5 mm thick and 15x25 mm² in cross-section, ground on all sides to a surface finish of R_a smaller than 0.00063 mm, were quenched and then tempered at 200°C prior to corrosion tests. The corrosion rate was measured by the weighing method but, considering the wide range of density, mass rate was converted to volume rate. The results of these tests indicate that matching the corrosion resistance of stainless steels requires hard alloys with a much higher Cr content, the difference increasing as the carbide content is increased. Abrasion tests were performed by rotation of specimens attached to the rotor of an electric motor in water with suspended 5 wt.pct quartz and of the 0.3-0.4 mm grain size fraction, the specimens being thus driven at a speed corresponding to a linear velocity of 5.5 m/s. This test was repeated with the addition of 0.5 wt.pct NaNO_2 to the suspension as corrosion inhibitor. In another test specimens were held in a jet of quartz sand blowing with a velocity of 80 m/s and impinging at a 30° angle of attack. The results of these tests indicate that the resistance to abrasive wear in corrosive media is determined by the corrosion resistance rather than by the hardness of alloys with a low corrosion resistance, their wear rate increasing as the TiC content is increased (despite the high corrosion and wear resistance of this carbide), and by the hardness in the case of alloys with a high corrosion resistance. References 7: all Russian.

UDC 548.736.4

New Ternary Compounds of Ge With Nd and Noble Metals

18420121d Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 1, Jan-Feb 89 (manuscript received 7 Jul 87) pp 206-208

[Article by P. S. Salamakha, O. I. Bodak, V. K. Pecharskiy, and V. K. Belskiy, Lvov]

[Abstract] New ternary compounds of Ge with Nd and a noble metal ($\text{NdRh}_{0.5}\text{Ge}_{1.5}$, $\text{NdPd}_{0.4}\text{Ge}_{1.6}$, $\text{NdIr}_{0.5}\text{Ge}_{1.5}$, $\text{NdPt}_{0.4}\text{Ge}_{1.6}$, $\text{Nd}_3\text{Ru}_4\text{Ge}_{13}$, $\text{Nd}_3\text{Os}_4\text{Ge}_{13}$, Nd_2IrGe_2) have been discovered. Their crystal structure was examined for a determination of the lattice parameters. Single crystals of Nd_2IrGe_2 were examined in a "Nicolet" automatic diffractometer with a MoK_{α} -radiation source and a plane graphite monochromator, using the theta-2.theta method with maximum 2.theta equal to 70°. These diffractograms were processed on a "Nova-3" computer using the SHELXTL program. Powders of all other compounds were examined in a HZG-4a automatic diffractometer with a CuK_{α} -radiation source and a Ni beta-filter, the 2.theta angle being scanned in 0.05° steps and the maximum 2.theta angle being equal to 120°. Primary processing of these polyprofile diffractograms was done of a "Robotron" A-5120 computer

using proprietary programs. Decoding and refinement of the structure by the powder method were done on an SM-4 minicomputer using the PMNK program. The results indicate that Nd_2IrGe_2 has a Sc_2CoSi_2 structure, $\text{Nd}_3\text{Ru}_4\text{Ge}_{13}$ and $\text{Nd}_3\text{Os}_4\text{Ge}_{13}$ have a $\text{Y}_3\text{Co}_4\text{Ge}_{13}$ structure, and the $\text{NdM}_x\text{Ge}_{2-x}$ (M- Rh, Pd, Ir, Pt) compounds have an AlB_2 structure. References 5: 3 Russian, 2 Western (1 in Russian translation).

UDC 669.2/.8:537.523.5

Kilohertz Frequency Band Discharges for Electric Arc Cleaning With Simultaneous Induction Annealing

18420115 Moscow TSVETNYYE METALLY
in Russian No 1, Jan 89 pp 109-111

[Article by G. F. Ignatyev and G. N. Churilov]

[Abstract] A kilohertz frequency band discharge was studied in air at atmospheric pressure. The installation was constructed so that the phase shift between the arc current and the magnetic field of the same frequency which was present could be smoothly varied from 0 to 2π . The plasma in the interelectrode gap was acted upon by a force compressing it to the axis of rotation, since its density was less than the density of the medium in which it was moving. The arc was judged to be suitable for emission spectroscopy, due to the localization of the electrode spot at the end of the central electrode, for the creation of plasmatrons with permanent electrodes and for cleaning of nonferrous metal rolled products combined with induction heating or hardening. References 10: 9 Russian, 1 Western.

UDC 669.018.25

Low-Tungsten Hard Alloy Based on Titanium Carbonitride

18420118a Moscow TSVETNYYE METALLY
in Russian No 11, Nov 88 pp 77-79

[Article by V. I. Tretyakov, G. G. Kupranova, O. I. Serebrova, E. F. Eykhmans, and G. V. Dubko]

[Abstract] Results are presented from the development of hard alloys based on titanium carbonitride with nickel-molybdenum binder with superior heat resistance to be used to replace the standard alloys T14K8 and T5K10. Heat resistance is improved by hardening the alloy with dispersed eutectic elements. The nickel-molybdenum cementing phase is hardened by the introduction of carbon and tungsten to form a eutectic, one element of which is a carbide-type hard compound. Hardness is increased from 1700 to 2500 N/mm² at 1000°C and wear resistance is significantly improved. References 4: 3 Russian, 1 Western (in Russian translation).

UDC 669.187.56:669.35'71.001.5

Electric-Slag Remelting of Aluminum Bronzes With Shape Memory Effect

18420100b Kiev PROBLEMY SPETSIALNOY
ELEKTROMETALLURGII in Russian
No 4, Oct-Dec 88 (manuscript received 10 Dec 87)
pp 39-41

[Article by G. Z. Zatulskiy, V. K. Larin, V. I. Tsabut, and V. V. Sharapanyuk, Kiev Polytechnical Institute; Experimental Special Electrometallurgy Plant (OZSEM), Electric Welding Institute imeni Ye. O. Paton, Ukrainian Academy of Sciences, Kiev]

[Abstract] Electric slag remelting of aluminum bronzes is performed on a type USh-116 unit forming an ingot in a water-cooled copper crystallizer. Remelting parameters are determined to produce an ingot with equiaxial fine-grained structure without liquation or shrinkage defects. The 1-2 mm slag liner is easily removed. References 3: all Russian.

UDC 669.295'24'3:669.018.6

Shape Memory Effect Features of Rapidly Hardened TiNi-TiCu Alloys

18420077d Moscow IZVESTIYA AKADEMII NAUK
SSSR: SERIYA METALLY in Russian
No 5, Sep-Oct 88 (manuscript received 25 Mar 87)
pp 138-142

[Article by Yu. K. Kovneristyy, L. A. Matlakhova, N. M. Matveyeva, and O. V. Kostyanaya, Moscow]

[Abstract] Research on mechanical characteristics relative to the structural state of rapidly hardened alloys of the TiNi-TiCu system has revealed that alloys crystallizing directly during cooling from a melt (10-20 at. percent Cu) or during annealing of the amorphous state (25-30 at. percent Cu) with the formation of rhombic martensite V19 (of the AuCd type) during cooling are plastic. The greatest strengths and hardnesses are observed for an alloy with 25 at. percent Cu. However, data are lacking on the characteristics of the shape memory effect (SME) of rapidly hardened alloys of the TiNi-TiCu system, such as the recovery stress σ_r and the maximum SME deformation reversible during heating. Accordingly, a study was made of the SME σ_r value and an evaluation was made of the deformations restored during the heating of rapidly hardened alloys of this system in the range of 10-30 at. percent Cu (due to a decrease in Ni content) in the case of deformation at room temperature. The maximum SME deformation restored during heating in an evaluation of the area of "pseudoflow" of rapidly hardened alloys of this system up to 30 at. percent Cu with a structure of martensite V19 in a crystalline state or crystallized from an amorphous state attains 4.5 percent. The maximum σ_r value for the alloys studied is attained with a residual deformation corresponding to the completion of the area of pseudoflow and, depending on

composition, is equal to 400-700 MPa. Increased σ_f values (500-700 MPa) are observed for rapidly hardened alloys of the system with 25-30 at. percent Cu crystallized from an amorphous state; this is attributable to the homogeneous microcrystalline structure. References 10: 9 Russian, 1 Western (in Russian translation).

UDC 669.018.45

Sintering of Ultradispersed Nitrides

18420113b Kiev POROSHKOVAYA METALLURGIYA in Russian No 10, Oct 88 (manuscript received 10 Feb 88) pp 32-34

[Article by P. S. Kislyy and M. A. Kuzenkova, Superhard Materials Institute, Ukrainian Academy of Sciences]

[Abstract] A study of "activated sintering" is performed and certain methods of activation during sintering of ultradispersed powders and the possibility of their use for ultradispersed ceramics are analyzed. Activity of powders can be achieved by compacting or by an increase in contacts between particles. Ultradispersed aluminum nitride and silicon nitride powders with 0.1-0.8 μm particle size were used to investigate the sintering process. Specimens were pressed from the powders and then sintered under 0.2-30 MPa nitrogen pressure. Active compacting is explained by processes occurring at the particle boundaries. Collective interaction of particles at the boundaries causes coordinated movement or rotation of the particles to form grain agglomerations with small disorientation angles, decreasing the activation energy greatly. Oxygen impurities present in ultradispersed particles may activate grain-boundary slipping. References 4: all Russian.

UDC [621.791.72.052:669.295]:620.17

Influence of Alloying Elements on Brittle-Fracture Tendency of Welded Titanium α -Alloy Joints

18420096A Kiev AVTOMATICHESKAYA SVARKA in Russian No 9 Sep 88 (manuscript received 17 Feb 87; in final form 24 Jun 87) pp 16-20

[Article by F. G. Gonserovskiy, candidate of technical sciences, Scientific-Production Association of Central Boiler and Turbine Institute imeni I. I. Polzunov]

[Abstract] The influence of aluminum, molybdenum, zirconium, vanadium, iron, chromium, silicon, and oxygen on crack resistance of various titanium α alloys was studied under static loading. Plates were electron-beam welded at 30 kV, 155 mA, 1 cm/s, then annealed at 750°C, one hour for VT5 and AT3 alloy, 880°C, one hour for VT20, TS5 and SPT2 alloys. Notches were made in the specimens on the welded seam root side. Increasing aluminum content is found to increase strength and decrease elongation by changing the phase composition of the alloys. Brittle fracture occurs in the cast metal at a lower content of aluminum, tin and other elements than in the base metal, the structural factor thus increasing

the negative influence of the phase factor. The greater affinity of zirconium, vanadium and tin for titanium causes these metals to have less negative influence. Oxygen and nitrogen decreased the ductility of the metal, increasing the negative effect of intermetallic phases. Alloying with iron, chromium and silicon greatly decreases elongation at fracture, particularly when oxygen is present. Addition of up to 2.6 percent zirconium or vanadium has no unfavorable influence on the titanium alloys studied. Annealing increases elongation in α alloys, but decreases it in alloys containing more of the alloying elements. Figures 3, references 5: Russian.

UDC 546.27.171:541.182.023.4

Some Structural Characteristics of Finely Dispersed Boron Nitride

18420021a Moscow POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA in Russian No 8, Aug 88 (manuscript received 18 Aug 87) pp 61-69

[Article by I. Yu. Gudkova, A. V. Rayevskiy, A. S. Rozenberg, and N. V. Chukanov, Chemical Physics Institute, USSR Academy of Sciences, Chernogolovka branch]

[Abstract] An experimental study of finely dispersed BN was made involving its structural examination under an electron microscope as well by infrared spectroscopy and x-ray phase analysis. The specific surface area served as the measure of dispersion. This was determined on the basis of nitrogen absorption according to the Brunauer-Emmet-Teller method. One specimen of commercial-grade hexagonal BN-10 (specific surface area 10 m^2/g) in its original state and others after their mechanical comminution to specific surface areas of 17, 79, 94, 175, 300, 500 and 675 m^2/g respectively were thus examined. The infrared spectra revealed a widening and shifting of absorption bands, a strong asymmetry of transverse-vibration bands and a weak asymmetry of longitudinal-vibration bands in commercial hexagonal BN, and an increasing role of surface characteristics relative to bulk characteristic with increasing degree of dispersion. Examination under an electron microscope revealed the fine structure of BN particles in the dispersed state, and x-ray analysis revealed a widening of the diffraction peak owing not only to microdistortions of the crystal lattice but also to finiteness of the size of the coherent-scattering zone and to instrument distortions. Quantitative evaluation of the lattice microdistortions by independent methods based on different models yields consistent results, indicating a high degree of disordering in the crystal lattice of finely dispersed BN. The authors thank O.L. Dubrava and V. G. Karatevskiy for supplying the specimens and O.I. Kolesova for the photomicrograms. References 25: 15 Russian, 10 Western (1 in Russian translation).

UDC 621.762+542.92

Chemical Interaction of Aluminum Alloy Powders With Water

18420111a Kiev POROSHKOVAYA METALLURGIYA in Russian No 8, Aug 88 (manuscript received 14 Apr 87) pp 15-19

[Article by N. A. Plakhotnikova, V. G. Gopiyenko, A. A. Kolpachev, and G. A. Reznikova, All-Union Scientific Research and Design Institute of the Aluminum, Magnesium and Electrode Industry]

[Abstract] A study was made of powders of alloys of the SAS(Al-Ni-Si), PV-90(Al-Mg-Zn-Cu) and AMLD(Al-Mg-Mn-Zr-Li) type by visual observation of the behavior of powders, measurement of solution pH, determination of alloy activity and study of hydrogen liberation kinetics upon interaction with water at various temperatures and suspension concentrations. The influence of various organic and inorganic corrosion inhibitors was also studied. Most active with respect to water were aluminum alloys containing magnesium, lithium, zinc, and other active elements. The reaction rate of the alloys with the water was determined by composition, temperature and quantity of suspension present per unit volume of water. AMLD, which contained lithium, reacted most rapidly with water. Introduction of inhibitors can prevent or significantly slow the reaction of the alloy powders with water.

UDC 621.762.5.001:539.4.42:620.18

Superelastic Behavior Upon Cyclical Deformation of Powdered Titanium Nickelide

18420111b Kiev POROSHKOVAYA METALLURGIYA in Russian No 8, Aug 88 (manuscript received 30 Mar 87) pp 26-30

[Article by S. M. Solonin, I. F. Martynova, V. V. Skorokhod, N. V. Klimenko, G. R. Fridman, and V. I. Kotenev, Institute of Materials Science Problems, Ukrainian Academy of Sciences]

[Abstract] A study is made of the behavior of powdered titanium nickelide under cyclical loading, with charges of powder as shaken down deformed in a 10 mm diameter press mold, the linear reversible height reduction being recorded. Several peculiarities of the manifestation of superelasticity were observed which were related to the heterogeneity of deformation of porous bodies: shape recovery was less than 100 percent; the elastic after-effect of the powdered TiNi was significantly greater than in compact specimens of the same material; the maximum point on the variation of reverse deformation as a function of initial deformation is shifted in the direction of higher initial deformation. Certain characteristic features of cyclical loading of powdered titanium nickelide are observed, including a significant lag in the degree of recovery upon first

loading in comparison to later cycles, and further compacting of the material upon repeated application of the same load up to 5-10 cycles. References 6: all Russian.

UDC 621.762

Influence of Physical-Chemical Factors on Structure of Cermet Layers Based on BaB_6 - LaB_6 System Boride Powders

18420111c Kiev POROSHKOVAYA METALLURGIYA in Russian No 8, Aug 88 (manuscript received 27 Apr 87) pp 61-65

[Article by I. M. Vinit'skiy, A. D. Panasyuk, B. M. Rud, and Ya. Ye. Telnikov, Institute of Materials Science Problems, Ukrainian Academy of Sciences]

[Abstract] A study is made of the influence of the chemical composition of BaB_6 - LaB_6 boride powders, the phase composition of their oxidation products, wetting of the current-conducting material by the liquid glass binder and the content of binder on the structure of cermet layers made from pastes, the major components of which are powders of a current-conducting material and a glass binder. It is found that oxidation of the surface of the powders allows the liquid glass to wet them, forming denser layers of the end-product material. Use of mixed borides, increasing liquid glass content and decreasing the softening point of the binder, all also tend to cause denser product layers. References 4: 3 Russian, 1 Western.

UDC 621.65:669.26:539.56

Micromechanical Properties of Boron Carbide-Based Materials

18420111d Kiev POROSHKOVAYA METALLURGIYA in Russian No 8, Aug 88 (manuscript received 30 Mar 87) pp 66-70

[Article by A. D. Panasyuk, V. R. Maslennikova, and V. F. Berdikov, Murom Affiliate, Vladimir Polytechnical Institute]

[Abstract] A study is made of the properties of new composite materials based on boron carbide to determine the possibility of their use as wear-resistant materials for hardening of machines and parts operating under intensive wear conditions. Specimens were prepared by hot pressing and subsequent annealing to relieve internal strains. Residual porosity was not over 5 percent. The microhardness of boron carbide-based materials with binders was less than the microhardness of pure boron carbide. Microbrittleness of the boron carbide-based phase was also less. Introduction of a

complex metal binder thus increases the ductility of new composite materials, increases their strength, and yet retains good hardness. References 6: all Russian.

Use of Biocidal Additives for Protection of Emulsion Against Biodegradation

18420124b Moscow METALLURG in Russian
No 12, Dec 88 pp 31-32

[Article by L. T. Zhalgasova, V. N. Solonin, Ye. A. Bender, V. I. Tevs, Yu. I. Gevaza, and V. N. Parshnikov, Karaganda Metallurgical Combine, Botany Institute and Organic Chemistry Institute, UkSSR Academy of Sciences]

[Abstract] Considering the high volume of emulsion used as lubricant-coolant for the rolling of steel and its degradability by microflora and bacteria, stabilizing biocidal agents are added for its protection for a service period of up to 2 years. The performance of two such agents, "karbotsid-114" and "karbotsid-213," with the ET-2U emulsifier for cold rolling and with the Ukrinol-211M emulsifier for extra-heavy duty has been found to be satisfactory on the basis of data on steel strip production and surface contamination/carburization at the Karaganda Plant.

UDC 621.762:539.378.3

Parameters of Hot Isostatic Pressing of Porous Materials

18420077a Moscow IZVESTIYA AKADEMII NAUK
SSSR: SERIYA METALLY in Russian
No 5, Sep-Oct 88 (manuscript received 8 Jun 87)
pp 92-99

[Article by A. M. Laptev, V. N. Samarov, and S. V. Podlesnyy, Kramatorsk]

[Abstract] A method for computing the principal parameters of hot isostatic pressing of powdered materials, based on the joint use of continuous and structural models of porous materials, is proposed and applied on a computer. A comparison of the results of computations and experimental data demonstrated the applicability of the method for practical purposes. Theoretical evidence was obtained of the substantial influence of the pressure and temperature of hot isostatic pressing (HIP): with an increase in temperature from 1300 to 1450 K this time for a powder of high-speed steel at a pressure of 100 MPa decreases by a factor of more than 6, but with a change in pressure from 100 to 12 MPa at 1500 K there is an increase by a factor of 58. In real HIP cycles the main compaction may already occur in the stage of rising temperature and pressure and is completed in the holding process, but in some cases the pressure release stage exerts no influence on the attainable density. In the initial compaction stages with HIP the main contribution to this process is from the gradual creep mechanism. In the final compaction stages the predominant influence is from diffusion along the boundaries of powder material particles. References 15: 7 Russian, 8 Western.

UDC 621.791.754:669.295

Resistance Welding of Titanium to Aluminum

18420125a Moscow SVAROCHNOYE
PROIZVODSTVO in Russian No 1, Jan 89 pp 4-5

[Article by A. F. Nesterov, candidate of technical sciences, A. P. Trubitsin, engineer, and A. N. Prokhorov, engineer, Moscow Aviation Technological Institute imeni K. E. Tsiolkovskiy]

[Abstract] Joining titanium and aluminum strips into bimetal laminates by resistance spot welding is considered, a major difficulty in producing a strong bond being the formation of the brittle intermetallic compound $TiAl_3$ almost instantly under high heat. Theoretical analysis of the problem on the basis of the temperature field equation, assuming that $\text{div}(k \text{ grad } U)$ is zero (k -thermal conductivity, U -potential space distribution function), takes into account the interaction of three materials in the pool, each with different electrical as well as thermal conductivity. This equation is formulated for a thick titanium strip and a thin aluminum strip stacked between the flat tips of two cylindrical electrodes, with axial symmetry of both electric and temperature fields. It has been solved numerically for WTi14 titanium alloy and 1420 aluminum alloy between either copper electrodes or Cr-Zn bronze electrodes. The results indicate the possibility of producing an adequately strong bond with an electric current pulse of optimum amplitude and duration which will ensure bonding in the solid-liquid phase under given temperature constraints. References 5: all Russian.

UDC 621.791.753.042.5

Automatic Welding Under Flux of Rolled Metal With Aluminum Coating Sprayed by Electric Arc and Air Blast

18420125b Moscow SVAROCHNOYE
PROIZVODSTVO in Russian No 1, Jan 89 pp 8-9

[Article by Ye. V. Voytsekhovskiy, candidate of technical sciences and V. I. Salamatin, engineer, Zhdanov Metallurgical Institute, and N. M. Popchenkov, engineer, Zhdanovtyazhmash Production Association]

[Abstract] Automatic welding of rolled strip of grade-3 carbon steel with aluminum coating was studied for the purpose of determining the effect of such a coating on the technology of the welding process and on the mechanical properties of the joint. Coatings were sprayed from a 2 mm in diameter Sv-AkMg wire on 10 mm thick plates with a $120 \times 300 \text{ mm}^2$ surface area and raw edges by means of an electric arc with a current of 260 A at 34 V and an air jet under a pressure of 0.6 MPa. Welding was done at a rate of 30 m/h with an Sv-08A wire 5 mm in diameter under AN-348 flux and a current of 700 A at 30-32 V. Plates were welded on both sides with the first seam produced on a flux cushion. The seams were examined by metallographic methods and

found to have a nondefective columnar microstructure. Increasing the thickness of coatings from 0.100 to 0.300 mm was found to increase the Al and Mg content but not the C and Si content in the seam. As a result, joints of coated strip are stronger but less plastic than those of uncoated strip. References 3: all Russian.

UDC 621.791.052:620.17

Properties of Welded Joints of Low-Ni Austenitic Steels at -196°C Temperature After Removal of Defects

18420125c Moscow SVAROCHNOYE
PROIZVODSTVO in Russian No 1, Jan 89 pp 9-10

[Article by Ye. I. Sabylin, candidate of technical sciences, and L. S. Livshits, candidate of technical sciences]

[Abstract] An experimental study concerning corrective treatment of welded joints of 10Mn14Cr14Ni4Ti and 07Mn20Cr13Ni4N₂ low-nickel austenitic steels for cryogenic applications was made, the fracture-prone zone of seam to parent metal bonding being preheated to a temperature within the 500-850°C range of intense carbide formation for removal of defects. Welding was done in two main passes followed by several rewelding passes, each pass delivering a heat of 23 kJ/cm and each pass preceded by treatment with a heat of 9.6 kJ/cm. The results of tensile tests performed at -196°C in liquid nitrogen for stress concentration and strain distribution analysis indicate that preheating for the second pass is most significant. They also indicate that preheating for a cumulative duration of 20 s can decrease the ultimate strength and the mean pre-rupture strain of 10Mn14Cr14Ni4Ti joints by as much as 10 pct and 70 pct respectively, but will only slightly decrease both strength and plasticity of 07Mn20Cr13Ni4N₂ joints.

UDC 621.791.3:621.791:67/68

Brazing With Zn Solder Instead of Sn-Pb Solders

18420125d Moscow SVAROCHNOYE
PROIZVODSTVO in Russian No 1, Jan 89 p 24

[Article by V. M. Borisov, engineer, Moscow Tekstil-mashdetal Plant and L. L. Grzhimalskiy, candidate of technical sciences, Moscow Instrument Building Institute]

[Abstract] The feasibility of dip brazing with Zn solder instead of Sn-Pb solder for assembly of a yarn-weaving loom is considered as an economy measure. An experimental study of this process modification was made, taking into account the narrow 430-460°C viscous flow temperature range for zinc as well as the 60 s time limit allowable for heating and joining small parts. Flux con-

taining 40 pct $ZnCl_2$, 2 pct $SnCl_2$, 1 pct KCl , 2 pct HCl , 1 pct NH_4Cl was found to facilitate spread of zinc over a sufficiently large area and to retain its activity at the brazing temperature near 500°C for just the necessary length of time. Brazing was also done with conventional POS-40 Sn-Pb solder for the purpose of process control.

UDC 621.791.72:621.373.826

Electrical Characteristics of Electric Arc Used in Laser-Arc Welding

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[Article by S. G. Gornyy, candidate of technical sciences, V. A. Lopota, candidate of technical science,s and V. D. Redozubov, engineer, Leningrad Polytechnical Institute imeni M. I. Kalinin]

[Abstract] An experimental study of dual laser-beam and electric-arc welding was made with an RS-1000 CO_2 -laser of 1 kW capacity and an electric arc in argon, the electrical characteristics of such an arc which determine its heat delivery being of interest. The cathode was a

nonconsumable tungsten electrode. Five different materials were used for the 5 mm thick, 50 mm wide, 100 mm long anode-target: 08Cr18Ni10Ti corrosion-resistant steel, WTi1-0 titanium alloy, Cu, Al and graphite. Current and voltage were measured and their oscillograms recorded directly during motion of the target strip under both heat sources so as to avoid overheating and breakdown of the target strip by focused laser energy, with the laser power regulated over the 1.0-0 kW range including the arc-only welding mode at zero laser power. A control computer was built into the laser apparatus for monitoring both stabilization of the laser beam at each power level and ignition of the arc at the corresponding voltage level. The arc current-voltage characteristics in each welding mode, including the arc-only welding mode, and the dependence of the arc voltage on the laser power indicate that the electrical conductance of the discharge gap is higher in the presence of a laser beam. The arc voltage was found below 20 V at any current over the 20-75 A range as the laser power was raised to 0.5 kW and to remain at that level with further increase of the laser power to 1 kW. References 3: 1 Russian, 2 Western (1 in Russian translation).

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